Bulletin of the
Government Museum, Chennai

BIODIVERSITY AND CONSERVATION

(Seminar Presentations - 2006)

General Editor

Dr. T.S. Sridhar, Ph.D., I.A.S.
Principal Secretary and Commissioner of Museums
Government Museum, Chennai - 600 008.

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Curator, Botany Section

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(Papers presented in the seminar on Biodiversity during 1st and 2nd of February, 2006 at the Museum Theatre, Government Museum, Chennai - 600 008)

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FOREWORD

Government Museum, Chennai has different sections of which the Botany section is one. As a part of the educational activity of this section, they have conducted a Bio-diversity Seminar on 01-02-2006 and 02-02-2006. Eminent person's have participated in the seminar and presented papers on different themes. The papers highlight the importance of maintaining our ecological balance to prevent pollution, tsunami and other factors affecting the environment. To maintain pollution free atmosphere it is essential that the ecological niche should be a balanced one. In this regard, these papers presented during the seminar on biodiversity would definitely serve the needs of the scholars, researchers, students and public. I also appreciate the efforts taken by Tmt. M.N. Pushpa, Curator, Botany, in coordinating with the various scholars to participate and present papers in the seminar and in bringing out this publication effectively.

Department of Museums thanks the Ministry of Culture, Government of India and Government of Tamil Nadu for rendering financial assistance towards this publication.

T. S. Sridhar

Principal Secretary &
Commissioner of Museums

Chennai-600 008,
Date : 04-03-2009.

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PREFACE

SEMINAR ON BIODIVERSITY

The Botany section of Government Museum, Chennai has several activities like conducting Courses, Seminars, Exhibitions, and rendering facilities for researchers. In this regard to create an awareness about conserving our Biodiversity, a seminar was conducted in the Museum Theatre on February 1st and 2nd, 2006, in collaboration with 'Arulagam', an NGO working on the Eco-development of Tamil Nadu. Thiru S. Bharathidasan, Secretary of Arulgam volunteered himself actively to associate with the Government Museum, Chennai to conduct the seminar. The Arulgam is also conducting many programmes in the Districts to create awareness among the public to conserve nature. The participants of the seminar were from different fields of Botany, from Museums, Colleges, Forest Department, Regional Museum of Natural History, National Biodiversity Centre, Plant Biology and Biotechnology Department and Nature Society, Students from various colleges in the city also participated in the seminar.

The seminar was conducted in four technical sessions covering the various aspects of flora and fauna. Thiru C.K. Sreedharan, I.F.S., the Principal Chief Conservator of Forest and Wild Life Warden, Department of Forest, Government of Tamil Nadu delivered the keynote address. I am much thankful to Dr. T.S. Sridhar, Ph.D., I.A.S., Principal Secretary and Commissioner of Museums for bringing out the seminar papers as museum publication.

I also thank Thiru M.A. Siddique, I.A.S., former Director of Museums for rendering support in organizing the seminar and all the staff who have involved themselves in making the seminar a success. My thanks are due to those who presented the papers and the participants making the seminar lively. I am thankful for the financial assistance rendered by the Ministry of Culture, Government of India and Government of Tamil Nadu for bringing out this publication.

Chennai - 600 008,
04-02-2009.

M.N. Pushpa,
Curator, Botany Section.

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I gratefully acknowledge all those who have involved themselves actively in bringing out this publication.

Editor
M.N. Pushpa

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I. BIODIVERSITY AND CONSERVATION
WHY CONSERVE BIODIVERSITY

Dr. S. Balaji, IFS*

The term **Biological Diversity** was coined by Lovejoy in 1980. Its constricted form **Biodiversity,** refers to the number, variety and variability found among living organisms. **Convention of Biological Diversity (CBD)** was signed by 157 nations in the Earth Summit held at Rio in the year 1992. CBD stresses the importance of conservation of biodiversity, sustainable use of its components and equitable sharing of the benefits coming out of them. Biodiversity is studied at three different levels viz. Ecosystem diversity, Species diversity and Genetic diversity. Forests, Grassland and Mangroves, represent diversity in different ecosystems. Species diversity is easily discernible. Globally about 1.4. million species have been described so far. India is endowed with 45,416 species of flora and 81,292 species of fauna. India also possesses 9,500 species of ethno botanical importance and 7,500 species of plants of ethno medicinal importance.

Tamil Nadu is rich in flora & fauna. There are over 5,239 species of plants & 594 freshwater animals 2,247 marine fauna. About 127 species of Flora are endangered as per BSI. To protect the threatened species of flora and fauna, **19 sanctuaries, 5 National parks, a tiger project area and two biosphere reserves** have been established by the Government of Tamil Nadu. **Environmental Information System ENVIS) node** of the Department of Environment has brought out the **first web based biodiversity profile** of the state. You can visit www.envis.tn.nic.in

Conserving Biodiversity is one of the stated objectives of National Forest Policy 1988. Our Tropical forests are rich in biodiversity. Soil, moisture and climate determine the Forest type and the nature of vegetation. A tree like *Bombax malabaricum* in a ***Shola*** can support the existence of a number of other species such as epiphytes, climbers, grasses, bryophytes, birds etc.,

Shannon-Weiner index is commonly used for Bio-diversity assessment. It gives species richness and relative abundance. Bioindicators like lichens, birds and butterflies could be used for assessing the change in Floristic diversity. Geographical Information System (GIS) is now used by the Forest Department in assessing macro level changes in vegetation.

Why should we conserve Bio diversity? According to Biocentric view Biodiversity has a value in itself, while anthropocentric view implies that Biodiversity conservation improves survival and well being of human beings. **Biodiversity is the very basis of human existence. Food, medicine, clothing, housing energy and other material needs are derived from Wild and domesticated biological resources which also provide spiritual and intellectual inspiration.**

Bio diversity prospecting within the carrying capacity of the land area can bring prosperity to the present as well as future generations. Therefore Biodiversity conservation is of paramount importance to the humanity. Biodiversity conservation implies living in harmony with nature. **As Gautama Buddha said "Eat your food to satisfy your hunger and drink to satisfy your thirst. Satisfy the necessities of life like butterfly that sips the flower without destroying its fragrance or its texture.**

Conservator of Forests,
Tamil Nadu Afforestation Project,
Forest Department,
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Chennai-600 015.

BIODIVERSITY AND ITS CONSERVATION

K. Venkataraman*

ABSTRACT

This lecture summarizes what is known of the biological diversity of India and their various ecosystems, from past literature, museum records and other lesser-known sources of information. The synthesis suggests that the number of species known could be of the order 45,000 species of flora and 90,000 species of flora or higher. However, the inventory is very detailed only in the case of commercially important groups and is very weak with respect to minor phyla or microbial organisms. In terms of spatial coverage, probably only two-thirds of the total area has been covered till today and the remote islands and other ecosystems still virtually remain untouched. It is, therefore, likely that true inventory of biodiversity could be several times higher than what is known today. Lack of trained taxonomists, however, is a serious constraint to achieve this. Biological resources have traditionally been a major source of food for local inhabitants and of major economic value in terms of commercial exploitation. The human exploitation of biological resources has increased dramatically in the last few decades for reasons, both commerce and subsistence living. Ecosystems and biological diversity of India have been exploited since long time but it is only in the last century that the rate of exploitation has increased dramatically, mostly due to the increase in the human population. Except for some of the Andaman-Nicobar Islands, no pristine area exists today. At the end of the last century or in the beginning of this century, very few areas of India remained unaffected, whereas most were partially deteriorated and a few were severely affected. Conserving what we have today is hampered by lack of management measures including outreach and our ability to predict what would live in India and lack of data relating changes in biodiversity to those of environment.

After an extensive and intensive consultation process involving the stakeholders, the Central Government has brought Biological Diversity Act 2002, with the following salient features:- i. to regulate access to biological resources of the country with the purpose of securing equitable share in benefits arlsing out of the use of biological resources; and associated knowledge relating to biological resources; ii. to conserve and sustainable use biological diversity; iii. to respect and protect knowledge of local communities related to biodiversity; iv. to secure sharing of benefits with local people as conservers of biologlcal resources and holders of knowledge and information relating to the use of biological resources; v. conservation and development of areas of importance from the standpoint of biological diversity by declaring them as biological diversity heritage sites; vi. protection and rehabilitation for threatened species; vii. involvement of institutions of state government in the broad scheme of the implementation of the Biological Diversity Act through constitution of committees. In accordance with the section 8 of Biodiversity Act 2002, National Biodiversity Authority is established to implement the Biodiversity Act 2002.

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INTRODUCTION

Biodiversity encompasses the variety of all life on earth. India is one of the 12 mega biodiversity countries of the world. With only 2.5% of the land area, India already accounts for 7.8% of the recorded species of the world. Biodiversity also includes countless millions of races, subspecies and local variants of species and the ecological processes and cycles that link organisms into populations, communities, ecosystems and ultimately the entire biosphere. A more easily recognized element of biological diversity is the distinct species. An association of species in an area is another recognizable element of biological diversity which is termed as community. Communities form the biotic components of ecosystems. Biologically diverse communities contain sufficient compositional, structural and functional variety that they are assured a high prospect of continued presence and ecological influence in an area. Biodiversity is mainly recognized at three levels, namely species level, genetic level and ecosystem level. Genetic diversity refers to variation within individual species; species diversity pertains to the variety of species; and ecosystem diversity refers to diversity of ecosystems and habitats. Biodiversity is dynamic at all three levels, the genetic composition of species changes over time in response to natural and human-induced selection pressures; occurrence and relative abundance of species in ecological communities change as a result of ecological and physical factors, ecosystems strongly respond to external dynamics and internal pressures.

Physical features of India

India is located in the South of Asia, between latitudes 6° and 38° N and longitudes 69° and 97° E. The Indian landmass, extending over a total geographical area of about 329 m ha, is bounded by the Himalaya in the North, the Bay of Bengal in the East, the Arabian Sea in the West, and Indian Ocean in the South. In terms of landmass, it is the seventh largest country in the world. Its coastline of about 8000 km extends over 200 nautical miles in the off-shore forming an Exclusive Economic Zone (EEZ) of 2.02 million sq km. India has a tropical monsoon climate. The South-west monsoons and North-east monsoons bring rain fall into India. Rainfall is unevenly distributed and it varies both temporarily and spatially. Western Ghats, along the States of Goa, Maharashtra, Karnataka and Kerala, West Bengal, and Assam receive an annual rain fall of 2000 mm. Maharashtra, Bihar, and Madhya Pradesh along the Vindhya Mountains receive annual average rainfall of 1000-2000 mm. South coastal plains and North Western Deccan and upper Gangetic plains receive an annual rain fall of 500-1000 mm. Hot desert areas of Rajasthan and Gujarat and the cold desert areas of Ladakh in Jammu and Kashmir and Lahul-Spiti in Himachal Pradesh receive an annual rainfall of 100 mm.

ECOSYSTEMS OF INDIA

The wide variety in physical features and climatic situations have resulted in diversity of ecological habitats like forests, grasslands, wetlands, coastal and marine ecosystems and desert ecosystems which harbour and sustain the immense biodiversity.

Forest Ecosystems

Forest cover of the country is 7,65,210 sq km (23.42%) while forest cover analysed by the satellite is 6,39,900 sq km (19.47%) (ICFRE, 2000). India is endowed with diverse forest types ranging from the Tropical wet evergreen forests in North-East to the Tropical Thorn forests in the Central and Western India. The forests of the country can be divided into 16 major groups comprising 221 types. The following are the forests types: 1. Tropical wet evergreen (North East and South and Andaman and Nicobar Island), 2. Tropical semi evergreen (South and East), 3. Tropical moist deciduous (Central and East), 4. Tropical littoral and swamp (Along the coast East and West), 5. Tropical dry deciduous (West and Central), 6. Tropical thorn (West and Central), 7. Tropical dry ever green (Central and South), 8. Subtropical broad leaved hill forests (South), 9. Subtropical pine (Sub-Himalayan tract), 10. Subtropical dry evergreen (North-East and South), 11. Mountain wet temperate (Himalaya and Nilgiris), 12. Himalayan Moist temperate (Temperate areas of Himalaya), 13. Himalayan dry temperate (Dry temperate areas of Himalaya), 14. Sub-alpine (Himalaya), 15. Moist Alpine shrub (Himalaya) and 16. Dry alpine shrub (Himalaya).

These forests provide several essential services to mankind. Forests are the source of a number of food items, fuel, wood, fodder, medicine and timber. Other economic uses include providing raw material for forest based industries. Some of the minor forest produce include gums, resins, honey etc. Forests perform important ecological functions such as maintaining delicate ecological balance, conserving soil, controlling floods, drought and pollution. Forests provide habitats for innumerable plants animals and microorganisms. Forests are a source of recreation and religious inspiration.

Most of the forest ecosystems in India are under acute form of degradation mainly due to i. loss of forest land due to agriculture, industries and human settlement, ii. loss of forest land due to multipurpose projects, construction of roads, erection of transmission lines, quarrying, shifting cultivation etc. iii. Degradation due to illicit felling lopping for fodder and fuel wood, overgrazing, forest litter removal, forest fires, over felling, conversion to monoculture, mining, army operations, introduction of exotics, fire and pollution and iv. human and cattle population exploitation around forest land. The other causes of degradation of this ecosystem are poverty, landlessness, derivation

of livelihood from forests, lack of land use planning, biotic interferences and lack of restrictive covenants and punitive legislations.

Grassland Ecosystems

Grassland means a landscape in which the grasses are the dominant plants. Grasslands are found in regions where climatic and edaphic conditions are such as to prohibit growth of trees. Lesser rainfall and frequent light showers keep the upper layers of soil moist so that grass continues to grow. In India grasslands occur in the form of village grazing grounds to extensive low pastures of dry regions to alpine Himalaya. The total area of grassland is estimated to be 3.9% or 12 m ha. Grasslands in the country also exhibit a diversity range from semi-arid pastures in Deccan peninsula, humid semi water logged grasslands of Terai belt, rolling shola grasslands on the hilltops of Western Ghats, and the high altitude alpine pastures of Himalaya. There are five types of grasslands which have been recognized in the country *viz.* i. Sehima-Dichanthium type, ii. Dichanthium-Cenchrus-Leaiurus type, iii. Phragmites-Saccharum-Imperata type, iv. Themeda-Arundinella type and v. Temperate-Alpine type. It is also estimated that the Indian grasslands harbour about 1,256 species belonging to 245 genera. Grasslands are of considerable economic value. Grasslands primarily support a large number of herbivore species from minute insects to the largest land animal the elephant. This in turn makes grasslands as hunting grounds of various carnivorous species of different sizes. Most of grasslands are used for production of milk, meat, wool and hides. A good stand of grasses and legumes on the soil checks erosion, prevents the loss of nutrients by leaching, improves the physical properties of soil and maintains a well balanced water regime. They are home for variety of organisms including wild mammals and birds. Some grasses are of medicinal value. Grasses exhibit a fairly good degree of endemism in India. There are about 18 genera endemic to India of which 13 of them are restricted to peninsular India. Natural calamities like forest fires, floods etc., overgrazing and various socio-economic developmental activities are the factors threatening grasslands. Severe destruction was caused to the natural vegetation in north-east India due to "Jhum" (shifting) cultivation. Most of the grasslands remain under severe grazing pressure throughout the year. The high altitude pastures and the arid and semi-arid grasslands in Uttar Pradesh, Madhya Pradesh, Haryana, Punjab, Rajasthan and Gujarat suffer from severe seasonal grazing stress by migratory livestock.

NATURAL AQUATIC ECOSYSTEMS

Wetland Ecosystem

Wetlands have been defined by more than fifty different ways to include a wide spectrum of habitats. The 1971 Ramsar Convention has defined wetlands as "areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt including areas of marine water the depth of which at low tide does not exceed six meters. Wetland is defined as transitional zones that occupy intermediate position between dry land and open water. These ecosystems are dominated by the influence of water, they encompass diverse and heterogeneous habitats ranging from rivers, flood plains and rain fed lakes to swamps, estuaries and salt marshes. India by virtue of its extensive geographical stretch and varied terrain and climate, supports a rich biodiversity of inland and coastal wetland habitats. It is estimated that India has about 4.1 m ha of wetlands (excluding paddy fields and mangroves), of which 1.5 m ha are natural and 2.6 m ha are man made.

Indian wetlands cover the whole range of the ecosystem types found. In addition to the various types of natural wetlands, a large number of man-made wetlands also contribute to the faunal and floral diversity. These man-made wetlands, which have resulted from the needs of irrigation, water supply, electricity, fisheries and flood control, are substantial in number. The various reservoirs, shallow ponds and numerous tanks support wetland biodiversity and add to the countries wetland wealth. Wetlands in India occupy 58.2 Million hectares, including areas under wet paddy cultivation (Directory of Indian Wetlands). Majority of the inland wetlands are directly or indirectly dependent on the major rivers like, Ganga, Brahmaputra, Narmada, Godavari, Krishna, Kaveri, Tapti.

Lotic Ecosystems

The Indian sub-continent, bounded by the Great Himalayan Arc in the north and by deep sea in the east, west and south, is traversed by large number of rivers, which played a major role in shaping the history of human civilization in the sub-continent. It has very rightly been said that the River Ganga has been cradle of civilization in the Indian sub-continent. The rivers have extensively been used for various purposes including irrigation, drinking water, recreation, fishing, transport etc. The rivers in India have been revered as mothers and worshipped as goddesses in this part of the world. In the last few decades, an exponential growth in human population, rapid urbanization and industrialization, intensive agriculture and growing demands for energy have all severely affected

the rivers of the region. The regulation of river flows and the discharge of domestic wastewater and industrial effluents have degraded the water quality of the rivers and declined the biological resources.

Wetlands are one of the most threatened habitats of the world. Wetlands in India, as elsewhere are increasingly facing several anthropogenic pressures. Thus, the rapidly expanding human population, large scale changes in land use/land cover, burgeoning development projects and improper use of watersheds has all caused a substantial decline of wetland resources of the country. Significant losses have resulted from its conversion threats from industrial, agricultural and various urban developments. These have led to hydrological perturbations, pollution and their effects. Unsustainable levels of grazing and fishing activities have also resulted in degradation of wetlands. Most problems pertaining to India's wetlands are related to human population. In the Indian subcontinent due to rice culture, there has been a loss in the spatial extent of wetlands. Alternative farming methods and fisheries production has replaced many mangrove areas and continues to pose threats. The shrimp farms also caused excessive withdrawal of freshwater and increased pollution load on water like increased lime, organic wastes, pesticides, chemicals and disease causing organisms.

Pollution is a major cause for the degradation of lotic ecosystems. While urbanization is often an integral part of development, rapid and unplanned growth may result in a wide impact on natural resources and the environment. Water pollution and freshwater depletion are currently viewed as the top environmental problem in Asian region. In India pollution of surface waters has become more severe and critical near the urban areas due to high pollution loads discharged within short stretches of rivers from urban activities.

It is believed that the major source of pollution in Indian rivers are point sources, viz. domestic sewage, industrial effluents etc as most of the information available concerning pollution in Indian rivers are those of point sources of pollution. Very little is known about the non-point sources of pollution. Moreover, many of the Indian rivers have large catchments area from where the pollutants from non-point sources flow into the rivers. The pollutants like organochlorines, organotins, and heavy metals in the rivers are mainly from the non-point sources of pollution.

Coastal and Marine Ecosystems

Coastal ecosystem plays a vital role in India's economy by virtue of their resources, productive habitats and rich biodiversity. India has a coastline of 7,516 km of which the mainland accounts for 5,422 km, Lakshadweep 132 km and Andaman and Nicobar islands for 1,962 km. Nearly 250 million people live within a distance of 50 km from the coast. The coastal area is assuming greater importance in recent years, owing to increasing human population, urbanization

and accelerated dcvelopmental activitics. The coastal regions are thus, a place of hectic human activity and the coastal ecosystems are now highly disturbed and very much threatened. Current approaches to the management of coastal resources are not capable of sustainable development and thc coastal environments and resources are being rapidly degraded and eroded in India.

The Indian mainland coast is divided into two parts: West Coast and East Coast. The West Coast is fronted by the Arabian Sea and the East Coast by the Bay of Bengal. Other than these mainland coasts, there are three island groups - Lakshadweep in the south Arabian Sea, Andaman group and Nicobar group, both in the eastern Bay of Bengal. The east and west coasts are markedly different in their geo-morphology. The West Coast is generally exposed with heavy surf and rocky shores and headlands. The East Coast is generally shelving with beaches, lagoons, deltas and marshes. It is also relatively low lying with extensive alluvial plains and deltas. The physical regime of the Indian coasts is characterized by different types of coastal and shore ecosystems like promontories (near Beypore in Kerala State), sand spits (at Karnataka and Andhra Pradesh), barrier beaches (along Kerala coast), embayments (Mirya bay in Maharashtra), estuaries and offshore islands.

Further, the coastal zone of India is also endowed with a very wide range of coastal ecosystems such as estuaries, lagoons, mangroves, backwaters, salt marshes, rocky coasts, sandy stretches and coral reefs which are characterized by unique biotic and abiotic properties and processes. More than half of the Indian coastline is sandy. The west coast of India is predominantly rocky consisting of rocky flats or lime stone rocks, often with overhanging cliffs formed of green to black basalt. Sandy areas, rivers and creeks interrupt the rocky coasts, and back waters of the coastal regions of India. On the East Coast, small stretches of rocky formations occur along Tamil Nadu and Andhra Pradesh.

Realizing the importance of the coastal ecosystems and their multiple uses, the ever-increasing human populations exploit not only the biological resources but also interfere and modify the basic coastal processes. Traditionally, coastal areas are highly populated and developed because they are the places where trade, transport, communication and civilization are well developed. In India, out of the three mega cities with population more than 10 million, (Delhi - 13.2 million, Bombay - 16 million and Calcutta 16.5 million), two are coastal cities ie. Bombay and Calcutta. The population density is also much more in coastal areas than the national average. For example, in the state of Tamil Nadu, the population density in coastal areas is 528 per sq. km against 372 per sq. km, which is state average. In parts of coastal metros like Bombay, Calcutta and Madras the population density ranges from 20,000 to 50,000 per sq km. The increased population pressure has led to resource depletion and environmental degradation due to coastal pollution, disposal of domestic

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wastes and industrial wastes. As in most of the developing nations, the coastal environmental problems and issues in India are also concerned with the following three main conditions: environmental degradation, resources reduction and user conflicts. The Integrated Coastal Zone Management (ICZM) plan has been recognized as a tool for addressing options that ensure livelihood security and environmental stability in coastal zones.

Coral Reef Ecosystems

Coral reefs form the most dynamic ecosystem providing shelter and nourishment to thousands of marine flora and fauna. They are the protectors of the coastlines of the maritime states. A few genera of corals are supposed to be older than prairies. This unique ecosystem is most productive because of its ability to retain and recycle nutrient elements within the ecosystem as well as within animal-plant associations. Though they are the builders of the most massive structures ever created by living beings in the world, they are very fragile and vulnerable to natural disturbances and human activities. Coastal populations mostly depend upon the coral reef ecosystem for their day-to-day life.

In India, all the three major reef types (atoll, fringing and barrier) occur, and the region includes some of the most diverse, extensive and least disturbed reef areas of the Indian Ocean, many of which are among the least scientifically known. The mainland coast of India has two widely separated areas containing reefs: the Gulf of Kachchh in the northwest, which has some of the most northerly reefs in the world, and Palk Bay and Gulf of Mannar in the southeast. There are patches of reef growth on the West Coast, for example at Malvan. The Andaman and Nicobars have fringing reefs around many islands and a long barrier reef (329 km) on the west coast. The reefs are poorly known scientifically but may prove to be the most diverse in India and those in the best condition. The Lakshadweep reefs are oceanic atolls but these are equally poorly studied.

Reefs are home to more species than any other ecosystem in the sea. The total number of reef species in the world is still unknown, but up to 3,000 species can be found together on a single reef in South East Asia and over 1,000 on a single Caribbean reef. Only tropical rainforests, estimated by some to be home to a staggering 30 million insects, have a greater number of species, although due to the vast number of fish that inhabit them, reefs contain a larger number of vertebrates than rainforests. Reefs also contain many more major animal groups (Phyla) than any other ecosystem on land or in the sea.

The richest reefs, with the greatest diversity of plants and animals are in the region bounded by Indonesia, Malaysia, the Philippines and southern Japan. Of the 700 or so reef coral species that

are known in the world, 600 are found in this region; over 400 are found in the Philippines and Japan, and about 350 in Indonesia, although there are probably many more to be discovered here. Up to 200 corals may occur on a single reef in South East Asia. This high diversity extends equally to other reef associates and is partly because of the greatest area of reefs found here and partly because of its geological history. When the sea level was lower, the region comprises of three separate basins, within each of which numerous species evolve. The variety of species on a reef decreases eastwards across the Pacific.

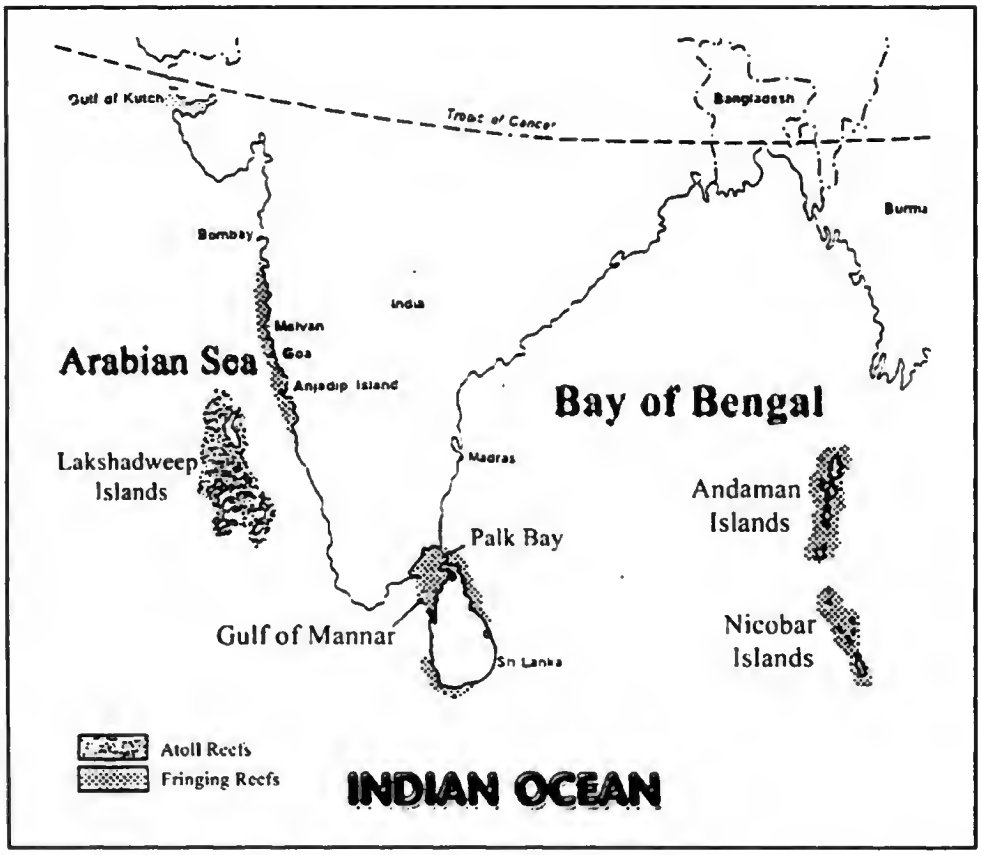

Fig 1. Map showing the major coral reef areas of India.

In India, the reefs are distributed along the east and west coasts at restricted places. However, all the major reef types are represented. Fringing reefs are found in Gulf of Mannar and Palk Bay. Platform reefs are seen along the Gulf of Kachchh. Patchy reefs are present near Ratnagiri and Malvan coasts. Fringing and barrier reefs are found in Andaman and Nicobar Islands. Atoll reefs are found in Lakshadweep. The absence of reef in Bay of Bengal (North East Coast) is attributed to the immense quantity of freshwater and silt brought by the rivers such as Ganga, Krishna and Godavari. Satellite imagery (SAC, Ahmedabad) shows scattered patches of corals in the intertidal

areas and occasionally at subtidal depths along the West Coast of India notably at Ratnagiri, Malwan and Rede Port.

A total of 199 species divided among 71 genera are recorded from Indian reefs Out of these 155 species are hermatypes (reef building corals) and 44 are ahermatypes (non reef building corals) (Pillai, 1996). A recent survey conducted jointly with the UNDP GEF and Indian experts in 12 areas of Andaman alone reveals an addition of 111 species of scleractinian corals form the shallow areas (up 15 m depth). The above study revealed a total of 223 species of Scleractnia from the Andaman Islands alone including the earlier report by Pillai, (1983).

Mangrove Ecosystems

Mangrove is one of the most extraordinary ecological formations occurring almost exclusively in the tropics. Like the tropical rain forests, the mangroves have also played a very important role in the economics of our coastal population for thousands of years, providing a wide variety of goods and services including wood production, support for commercial and subsistence fisheries, aquaculture, salt production and shoreline and coastal erosion control.

Mangroves are salt-tolerant forest ecosystems of tropical and subtropical intertidal coastal regions near river mouths. Between latitudes 30^0N and 30^0S, the shoreline marsh vegetation is replaced by mangals (a community of mangroves is termed as mangal). They form highly productive ecosystems since the inorganic nutrients, brought in by the incoming freshwater from land run-off, are trapped to form the source of energy for many organisms. A mangrove ecosystem constitutes a reservoir, refuge, feeding ground and nursery for many useful and unique plants and animals confined to this region. Through the export of decomposable organic matter into adjacent coastal waters, the mangroves provide an important nutrient input and primary energy source for many tropical estuaries. The mangrove ecosystem also protects coastal areas from sea erosion and from the violent effects of cyclones and tropical storms. The warm, calm waterways of mangroves provide shelter and rich food for many juveniles and larvae of finfish and shellfish.

India has only 2.66% of the world's mangroves, covering an estimated area of 4827 sq km. The East Coast is endowed with the world's largest mangrove forest, the Gangetic Sunderbans in West Bengal. The Sunderbans mangroves are of the deltaic type. The 2109 km^2 area of Sunderbans has 30 of the 50 species of the true mangroves in the world. The mangrove area in Orissa is nearly 200 km^2 in extent and its degradation is placed at 20 km^2 over ten years, as per recent estimates. Andhra Pradesh has about 582 km^2 of mangrove area. The area under mangrove ecosystem in Tamil Nadu is about 225 km^2. One of the largest and most unspoiled mangrove forests in

Tamil Nadu is at Pitchavaram in Cuddalore District, extending over an area of 1100 ha. Out of India's total area under the mangroves, about 57% are found on the East Coast, 23% on the West Coast and remaining 20% on the Bay Islands (Andaman and Nicobar).

There are three types of mangroves in India viz., deltaic, backwater-estuarine and insular categories. The deltaic mangroves occur on the east coast (Bay of Bengal) where the mighty rivers make the deltas. The backwater-estuarine type of mangroves of the west coast exists along the typical funnel-shaped estuaries of major rivers (Indus, Narmada, Tapti) or backwaters, creeks, and neritic inlets. The insular mangroves are present in Andaman and Nicobar Islands, where many tidal estuaries, small rivers, neritic islets, and lagoons support a rich mangrove flora. The multiple uses of the coastal zone, in general, and the mangroves in particular, like recreation, tourism, forestry, agriculture, aquaculture, housing and commercial fishing are all well known, as also the fact that this zone is very highly productive and also thickly populated. A major concern with the increasing use of this zone and its resources, not only for the present but also for posterity, relates to coastal pollution by domestic industrial, municipal and agricultural wastes and of late due to oil exploration.

Sea grass and Seaweed Ecosystems

Sea grasses occur in the infratidal and midtidal zones of shallow and sheltered localities of sea, gulf, bays, backwaters and lagoons. They are submerged monocotyledonous plants and adapted to the marine environment for completion of their life cycle under water. They occur along the east and West Coast and Andaman and Nicobar Islands. They form a dense meadow on sandy and coral rubble bottoms and sometime in the crevices under water. In India the earlier studies revealed that about 14 species are found along the Indian coast. The dominant species are *Cymodium rotundata, Enhalus acorodies, Halodule pinifolia, H. uninervis, H. wightii, Halophila beccarii H. decipiens, H. ovalis, H. ovta, H. stipulacea, Syringodium isoetifolium* and *Thalassia hemprichii.* About 9 species are extensively found in Andaman and Nicobar Islands. The unique ecological importance of the seagrasses for the conservation of rare and endangered animals like marine turtles, dugongs, some common echinoderms, juvenile prawns and fishes is very well known.

The seaweed communities prefer somewhat flat and rocky coastal wetlands that gradually slope towards the sea with marked tidal effect of complete submergence during high tide and successive exposure during low tide. Their distribution extends from open shore formation to interdial lagoons, bays, rock pools, and puddles or in creeks and inlets beyond the low tide mark along the infralittoral region of the coast. Different species are abundant along the West Coast, Andaman and Nicobar Islands and Lakshadweep. Except for places like Chilka, Pamban and Cape Comorin, their occurrence along the East Coast is very scanty.

About 120 species of seaweeds have so far been recorded from the coastal wetlands in India. Some of the important seaweeds are *Enteromorpha compressa, Ulva lactuca, Acetabularia crenulata, Dictyosphaeria cavernosa, Chaetomorpha media, Caulerpa corynephora, C. paltata, Odium iyengarii, C. tomentosum, Halimeda macroloba, Dictyota atomarica, Ectocarpus breviarticvulatus, Polysiphonia vaariegata, Grateloupia indica* and *Sargassum duplicatum*. These plant communities serve as sustainable life support in the field of food, shelter, fertilizer, production of iodine, potash, glue, agar, algin, vitamin, antibiotic and others. Detailed studies on Indian seaweeds, their survey, quantitative assessment and different problems for extracting valuable products for commercial export are to be given more emphasis in the future.

Desert Ecosystems

The district Rann of Katchchh or Kutch-Buj in Gujarat state forms separate agroclimatic zone within the Thar Desert of India and is spread over 62,180 sq km which comes to about 22.34% of the entire Thar. This ecosystem exhibits a spectacular biological diversity because of its evolutionary history, geographical location and ecological uniqueness of the Thar Desert. Unfortunately, this region of Indian desert remains significantly unexplored for biodiversity, especially eastern Kachchh. Because of the unique ecological conditions and habitats some of the species are endemic to this region. The analysis of the literature reveals that there are about 700 species of flowering plants of which 345 species are indigenous to Kachchh. The Kachchh Coast of Arabian sea is about 338 km long consisting of an area of about 2500 sq km of which 709 sq km is covered with mangrove forest. Fauna of this ecosystem is virtually under explored. Several groups of marine invertebrates, *viz. Coelentrates* (36 spp of corals) 11 species of *echiurans*, 72 species of *mollusca*, 42 species of *bryozoans* have been reported from this area. In the hot desert of Thar only a few species of the major phyla like *Protozoa, Cnidaria, Platyhelminthus, Nematoda* have been reported till date. The members of the phylum *Arthropoda* constitute the largest and one of the most economically important groups of animals. They are represented by 23 species of *Isopoda*, 6 species of *Diptera*, 10 species of *Coleoptera*, 20 species of *Lepidoptera*, 6 species of *Odonata*, 9 species of *Metasigmata* (*Acari*) and a few others. The information on the distribution of scorpions, pseudoscorpians, ticks and spiders is almost nil from this ecosystem. The vertebrate fauna of Thar Desert except the fishes has drawn considerable attention of the zoologists. In all, about 317 species of vertebrates are known from the Great Kachchh region. This includes 20 species of fishes, 6 species of amphibians, 35 species of reptiles, 220 species of birds and 36 species of mammals.

BIODIVERSITY

India is very rich in terms of biological diversity due to its unique bio-geographic location, diversified climatic conditions and enormous eco-diversity and geo-diversity. India embraces three major biological realms, *viz.* Indo-Malayan, Eurasian and Afro-tropical and is adorned with 10 bio-geographic zones and 26 biotic provinces.

PLANT DIVERSITY

About 850 species of bacteria, 14,500 species of fungi 6,500 species of algae and 17,500 species of flowering plants are reported from India till today (Botanical Survey of India web site) (Table 1). At national level the information on flowering plants is being documented in the form of Fascicles of the Flora of India and the Flora of India. So far, 24 Fascicles have been brought out by the Botanical Survey of India. So far, eight volumes covering general aspects of Flora of India, such as physiography; geology; climate; botanical history; phyto-geographical divisions; endemism; centers of diversity and phyto-geographical affinities; exotics; ethno-botanical, medicinal and plants of other economic value; plant based industries; wild relatives of cultivated plants; endangered plants, habitats and their conservation; protected area network; botanic gardens and the statistical analysis of the flora have been published by the Botanical Survey of India.

Table 1. The number of plant species belonging to major group expected to occur In India / World.

Group	No. of Species Described		No. species Guess Estimates	
	India	World	India	World
Bacteria	850	8050	85000	400000
Fungi	14500	70000	328570	1000000
Algae	6500	40000	12500	200000
Seed Plants	17500	250000	20247	300000

Table 2. The number of species of major group of plants and micro organism described and estimated from India and world

Plant Groups	No. of species described		% of India to the World	Estimated number
	India	World		World
Virus	850	8,050	10.6	9,00,000
Bacteria				
Algae	6,500	40,000	16.3	3,50,000
Fungi	14,500	72,000	20.1	10,00,000
Lichens	2,021	13,500	15.0	20,000
Liverworts	845	7,500	11.3	9,000
Mosses	1,980	7,000	28.3	9,000
Pteridophytes	1,200	10,000	12.0	12,000
Gymnosperms	48	650	7.4	650
Angiosperms	17,500	2,50,000	7.0	3,00,000

Table 3. The dominant plant families of India and their proportion to the global diversity

Family	Number of Genera		% of India to the World	Number of species		% of India to the world
	India	World		India	World	
Poaceae	260	500	52.0	1200	8000	15.0
Fabaceae	191	590	32.4	1152	14200	8.1
Orchidaceae	166	800-1000	20.7 - 16.6	1141	25-35000	4.6 - 3.3
Asteraceae	167	1100	15.2	950	20000	4.75
Rubiaceae	115	450	25.6	659	6500	10.14
Cyperaceae	38	70	54.3	545	4000	13.6
Euphorbiaceae	84	300	28.0	528	7500	7.0
Acanthaceae	92	250	36.8	510	2500	20.4
Roseceae	40	100	40.0	492	3000	16.4
Lamiaceae	72	200	36.0	454	3200	14.2

FAUNAL DIVERSITY

Based on the data collected from the experts of different animal groups, total number of species belonging to the Kingdom *Protista* (*Protozoa*) and Animalia reported from India is 89,451 of which insects alone include 59,353 species. Many lower groups of animals that occur in India have not received adequate attention, while others like *Nemertinea, Nematomorpha, Priapulida, Pogonophora* and *Pentastomida* are not known at all in India.

It reveals that amongst invertebrates, parasitic forms (eg. *Mesozoa, Acanthocephala* and *Platyhelminthes*), some Meiofauna (*Kinorhyncha, Gastrotricha*) and Soil Fauna (*Annelida*) exhibit a very high degree of endemism at species level. Overall 34.90% of insect species are endemic to the Indian region whereas more than 40% of Indian leech, freshwater sponges and molluscs also show endemism. Among vertebrates highest degree of endemism at species level is seen in *Amphibia* followed by *Reptilia, Aves, Mammalia* and *Pisces*.

Invertebrate Fauna (other than arthropods):

Protista (*Protozoa*) is represented by 1330 parasitic species (52%) and 1247 free-living (48%) totaling 2577 species in India as against 32% parasitic and 68% free living species in the world. It may be mentioned that the parasitic species are well studied because many of them are associated with certain dreaded diseases of man and animals. However, it is estimated that the number of species in *Protozoa* so far known is only one-fourth of the species expected to occur in India.

The *Mesozoa* known in India is 10 species as against 71 species in the world (approx. 14%) remain as a subject of further research.

Porifera is represented by 486 species of which 455 are marine and 31 freshwater accounting for over 10% of the species known in the world. It may be mentioned that the marine fauna known in India shows a close relationship with those in the Australian region, the Pacific Ocean and the Red Sea.

While there are 842 species of the *Cnidaria* known in India as against 9916 species in the world (8.49%), the *Ctenophores* register only 12 in number.

The *Platyhelminthes* or flat worms are mostly parasitic and constitute only 9.27% of the world-fauna. The free-living *Turbellarians* with only 47 species (approx.1% of the world fauna) have received very little attention. Of the *trematodes*, most of the Monogenea numbering 295 are

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known from freshwater fishes but there is a big lacuna with regard to marine- fishes. The other groups like *Trematoda* and *Cestoda* with 750 and 530 species respectively are required to be explored with the multiplicity of hosts available in our country.

Among the plankton, rotifers constitute a dominant phylum with 330 species, a little over 13% of the world fauna. A critical analysis of the Indian freshwater rotifers indicates that various planktonic and semi-planktonic taxa are fairly known from this country but periphytic, benthic, colonial, sessile and delloid rotifers are still to be much studied. Of the marine meiofauna, 110 species represent *Gastrotricha* and *Kinorhyncha* respectively, accounting for 3.33% and 10% of the species known in the World. It is interesting to note that there is high degree of endemicity in these groups. The groups like *Sipuncula* and *Echiura* with 35 and 43 species in India account respectively for about 24% and 34% of the world-fauna. All these groups exhibit very high biological diversity in Andaman & Nicobar Islands.

Nematodes constitute about 90% of all metazoa in the world and occur in every possible type of habitat, free-living or predaceous or parasitic in plants and animals. Animal parasitic nematodes numbering 1,000 and plant, soil and other nematodes recording 1850 species account for 9.5% of the world fauna. Our knowledge on the nematode parasites in vertebrate animals is satisfactory but plant, soil and aquatic (both freshwater and marine) nematodes are poorly known.

Acanthocephala, is known to occur in India, form nearly 29% of the world fauna. Among other minor phyla, *Phoronida* and *Brachiopoda* represented by 3 species each are the least known groups in India. However, *Bryozoa* with 200 species is known better than the *Entoprocta* (10 species) or even the *Chaetognatha* (30 species) and the *Tardigrada* (30 species).

Annelida in India constitute about 6% of the world-fauna and though *polychaetes* are comparatively well known, knowledge of brackish water groups is far from satisfactory. *Molluscs* are of great diversity with 5070 species and account for about 8% of the world fauna. Our knowledge on the marine *molluscs* as compared to the land and freshwater ones is far from satisfactory. It is interesting to note that both the land and freshwater *molluscs* have a number of endemic genera and species. *Echinodermata* represented in India by 765 species (nearly 12.5% of the world fauna) is well studied except for the deep-water forms of the Indian region.

Although the *Onychophora* as a group is extremely rare, it is known by a single species discovered at the foot of the eastern Himalayas in North-east India.

ARTHROPODA

The phylum *Arthropoda* is remarkable in having the largest number of classes, orders, families, genera and species in India. *Crustacea* is one of the major classes of the phylum with 2934 species being over 8% of those in the world. *Arachnida*, another major class is known by 5818 species, which is also nearly 8% of the world fauna. *Chilopoda* and *Diplopoda* with 100 and 162 species are only over 3% and 2% respectively of the fauna in the world. The other groups under the Arthropoda except the Insecta are poorly known. The Xiphosura is of special interest with 2 species in India. All these groups need special attention because much remains to be known about them.

Insects

Insects so far known in India are grouped in 27 orders, of which 4 are *apterygotes* and the remaining 23 are *pterygotes*.

Apterygota

Among *apterygotes* in India, *Collembola* is known better than the other 3 groups. It is represented by 210 species (above 4.0% of the world fauna) under 86 genera as against 451 genera in the world. The other 3 groups, viz., *Thysanura*, *Diplura* and *Protura* are known by 31 species (nearly 2.5%) under 16 genera, 16 species (4.5%) under 7 genera and 20 species (nearly 7.7%) under 8 genera respectively. It may be mentioned that the endemism is quite remarkable in the groups with 22 genera and 45 species in the *Collembola*, 12 genera and 23 species in the *Thysanura*, 3 genera and 12 species in the *Diplura*, and 4 genera and 16 species in the *Protura*. Indeed, our knowledge on the Indian apterygote groups is poor and therefore, much more attention requires to be paid in order to reveal the tremendous biodiversity among them.

Pterygota

Of the *pterygotes*, Coleoptera is the largest of all the Orders and is known by 15,500 species (nearly 4.5% of the world fauna), followed by *Lepidoptera* with 15,000 species (over 10.5%), *Hymenoptera* with 10,000 species (over 8%), *Hemiptera* with 6,500 species (over 8%) and *Diptera* with 6,093 species (over 6.0%). As regards the endemic species of these groups in India, it is estimated that *Hymenoptera* contains 9,000 species and 516 genera in 65 families, *Coleoptera* with 3,100 species and 923 genera in 104 families, *Hemiptera* has 2,421 species and 579 genera in 77 families, *Diptera* with 2,135 species and 107 genera in 87 families and *Lepidoptera* nearly 1,500 species and 100 genera in 84 families.

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Besides the above major groups, *Orthoptera* is ranked next with over 1750 species that account for over 10.0% of the fauna in the world. There are 77 endemic genera and over 200 species in this order.

So far in India, two orders, *viz., Trichoptera* and *Thysanoptera* that register 812 species under 112 genera and 693 species under 249 genera respectively. *Trichoptera* has 650 endemic species while *Thysanoptera* possess 520 species.

The diversity of the following 5 orders is extremely interesting, *viz., Odonata* with 499 species under, 139 genera, *Phthiraptera* with 400 species under 85 genera, *Neuroptera* with 335 species under 125 genera, *Dermaptera* with 320 species under 74 genera and Isoptera with 253 species under 54 genera. *Endemicity* in these groups are high, *Odonata* with 115 species, *Phthiraptera* with 16 species, *Neuroptera* with 262 species, *Dermaptera* with 117 species and *Isoptera* with 170 species.

Five groups of insects that register less than 200 species are *viz., Blattaria* represented by 186 (nearly 4.0% of the world fauna), *Mantodea* with 162 species (a little over 7.0%), *Phasmida* with 146 species (nearly 6.5%), *Plecoptera* with 113 species (nearly 5.5%) and *Ephemeroptera* with 106 species (nearly 5.0%), that includes 60, 86, 70, 66 and 72 species respectively as endemic to India.

The fauna of the last five remaining orders, *i.e., Psocoptera, Siphonaptera, Embioptera, Mecoptera* and *Strepsiptera* are insignificantly known with 90 species (over 3.0%), 52 species (over 2.5%), 33 species (16.5%), 15 species (over 4.0%) and 18 species (over 3.0%) respectively.

VERTEBRATE FAUNA

Protochordates includes two subphyla *viz., Cephalaochordata* and *Tunicata* exlusively distributed in marine environment, the total number of species from the Indian marine water is 119, thus a share of 5.65 percent of the estimated taxa of the world.

Pisces

Fishes comprise about half the number of vertebrate species described so far from the world. The world's fish diversity is estimated to be 21,723 extent species under 4,044 genera, 445 families and 50 orders. The Indian fish diversity represents 11.72 % of the world, comprising of 2546 species under 969 genera, 254 families and 40 orders. The class *Chondrichthyes* comprises 131 species under 67 genera, 28 families and 10 orders, while the class *Osteichthyes* is represented by 2415 species belonging to 902 genera, 226 families and 30 orders.

Amphibia

The Indian *amphibia* comprises of 211 species under 38 genera, 9 families and 3 orders. The amphibian species are not evenly distributed throughout India, the highest concentration is found in Western Peninsula followed by Northeast. Interestingly all the three living orders of *Amphibia viz. Gymnophiana*, *Caudata* and *Anura* are distributed in North- east India, the Western Peninsula has *Gymnophiana* and *Anura* while the rest of the country harbours only *Anura.*

Reptilia

Reptiles were the dominant group of vertebrates during the mesozoic period, the end of Triassic established most of the orders of reptiles and some became extinct at that time. Of the 19 orders of Reptiles only 4 survive today (*Crocodelia, Testudines, Squamata* and *Rhynchocephalia*). Reptilian fauna has great affinity to the Oriental Region as well as a close relationship to the Indo-Chinese and Indo-Malayan Region.

Aves

Birds evolved about 150 million years ago, occupied all ecological niches and are distributed in all habitats. The sub-continent avifauna includes Palearctic, Oriental, Ethiopian, and Australasian zoogeographic elements, and has about 176 endemic forms and 350 species and subspecies which in winter in the Indian territory, while a few migrate from India. 9026 species under 1800 genera, 182 families and 30 orders of birds are recorded till date in the world. About 437 are designated as threatened for their survival. The Indian subcontinent has 1232 species, 2123 species and sub-species under 78 families and 20 orders representing 13.66 % of the world diversity. About 47 species have been designated as threatened, 3 are suspected to be extinct.

Mammalia

The mammalian fauna of the world is represented by 4629 species belonging to 1135 genera, 136 families and 26 orders (Wilson and Reeder, 1993). Of these, 390 species belonging to 180 genera, 42 families and 13 orders are found in the Indian Union. Another 13 orders do not occur in our country.

Estimated number of described species

Taxonomic group	No. of species		% in india
	World	India	
PROTISTA (Protozoa)	31250	2577	8.24
ANIMALIA			
Mesozoa	71	10	14.08
Porifera	4562	486	10.65
Cnidaria	9916	842	8.49
Ctenophora	100	12	12.00
Platyhelminthes	17500	1622	9.22
Nemertinea	600	-	-
Rotifera	2500	330	13.20
Gastrotricha	3000	100	3.33
Kinorhyncha	100	10	10.00
Nematoda	30000	2850	9.50
Acanthocephaea	800	229	28.62
Sipuncula	145	35	24.14
Mollusca	66535	5070	7.62
Echiura	127	43	33.86
Annelida	12700	840	6.61
Onychophora	100	1	1.00
Arthropoda	**987949**	**68389**	**6.90**
Crustacea	35534	2934	8.26
Insecta	867391	59353	6.83
Arachnida	73440	5818	7.90
Pycnogonida	600	16	2.67
Chilopoda	3000	100	3.33
Diplopoda	7500	162	2.16
Symphyla	120	4	3.33
Merostomata	4	2	50.00
Phoronida	11	3	27.27
Bryozoa (Ectoprocta)	4000	200	5.00
Entoprocta	60	10	16.66
Brachiopoda	300	3	1.00
Chaetognatha	111	30	27.02
Tardigrada	514	30	5.83
Echinodermata	6223	765	12.29
Hemichordata	120	12	10.00
Chordata	**48451**	**4952**	**10.22**
Protochordata	2106	119	5.65
Pisces	21723	2546	11.72
Amphibia	550	219	4.20
Reptilia	5817	456	7.84
Aves	9026	1232	13.66
Mammalia	4629	390	8.42
Total (*Animalia*)	1196903	86874	7.25
Grand Total (*Protista+ Animalia*)	**1228153**	**89451**	**7.28**

THREATS TO BIODIVERSITY

Biological resources have traditionally been a major source of food for local inhabitants and of major economic value in terms of commercial exploitation. The human exploitation of biological resources has increased dramatically in the last few decades for reasons, both commerce and subsistence living. Ecosystems and biological diversity of India have been exploited since long time but it is only in the last century that the rate of exploitation has increased dramatically, mostly due to the increase in the human population. Except for some of the Andaman-Nicobar Islands, no pristine area exists today. At the end of the last century or in the beginning of this century, very few areas of India remained unaffected, whereas most were partially deteriorated and a few were severely affected.

Natural threats

The major stresses on terrestrial ecosystems removal of top soil by flash flood and destruction earth quake and the marine ecosystems by storm and waves, particularly cyclones. Cyclonic disturbances develop during October-November along the coast. These cyclones have sustained winds with speed ranging from 65 to 120 km per hour. High-speed winds cause extreme wave action that kills many fauna and flora, also break coral into rubbles and sometimes-large amounts of sand and other materials may be dumped onto the coral reef. Also freshwater runoff kills many fauna and flora in semi-enclosed bays and lagoons by lowering salinity and depositing large amounts of sediments and nutrients.

Human impacts

Varied human activities which are, a cause for concern over and above the natural disturbances, include habitat destruction due to development, industrialization, pollution, eutrophication due to bad agricultural practices, runoff and sedimentation from development activities (projects), eutrophication from sewage and agriculture, physical impact of maritime activities, dredging, collecting, and destructive fishing practices, pollution from industrial sources and oil refineries and the synergistic impacts of anthropogenic disturbance. A general rule for coastal zone is: whatever is used on land today ends up in the aquifer or coastal zone tomorrow. The amount of sediments and chemicals the runoff water carries to the sea has profound effects on fertilization of eggs of marine species. Likewise, the quality of runoff water can affect the metamorphosis of the larvae of many species. Oil pollution induces mortality, decrease fecundity and fail recruitment. India has three mega cities, many small, medium and major ports and industries

around the 8000 km coast. The enactment of Water Pollution Act in 1974 and Environment Protection Act, 1986 have helped in regulating the disposal of wastes from the industries. These measures have resulted in reduction of pollution loads of the coastal waters to certain extent. Major industries like fertilizer, petro and agrochemical and chemicals are mainly located along the coasts. Besides industrial and municipal wastes, port related operations such as continuous movement of marine vessels in the major ports including oil transport as also the wastes of aquaculture and agriculture farms are increasingly posing threats to the coastal water quality and to the biodiversity.

Fishing is a major activity in the coastal regions of India and at present in the 3651 fishing villages situated along the 8129 km coastline of India, about one million are occupied full time in marine capture fisheries. The value of the annual marine fish production of 4.6 million tones during the year 2002-2003 and the value of marine products export was Rs 6,881.31 crores (US $ 152.92 m). This is mainly due to the introduction of bottom trawlers, which was introduced in the Indian water in the early 1960s. Several types of net fishing have also been responsible for over-exploitation of marine resource. The use of fish traps made of long-lasting materials with small mesh sizes results in the capture of pre-reproductive juveniles affecting future populations and the death of fish when traps become dislodged during storms, continue to capture fish, which eventually starve. Fishing operations with latest technologies are causing damage to the marine living resources. Along with increase in the targeted catch, a number of untargeted fish and other biota are removed from their habitat and discarded as waste. Shrimp trawlers probably have the highest rate of by catch bringing in up to 90% more of "trash fish". Random capture techniques destroy immature fish and other non-targeted marine species. Gill nets used to catch fish bring in a host of other animals such as dolphins, turtles, *etc.* Because of the large size of the areas concerned (Gulf of Mannar and Andaman and Nicobar Islands or other areas in India), and the general lack of resources for enforcement, awareness appears to be more successful than legislation in controlling these practices

Conservation of bioresources through Biological Diversity Act, 2002.

The Convention on Biological Diversity (CBD) is a landmark in the environment and development field, as it takes for the first time a comprehensive rather than a sectoral approach to the conservation of Earth's biodiversity and sustainable use of biological resources. It was in the year 1984 that the needs to have in place a global convention on biological diversity started gaining momentum. In response, the United Nations Environment Programme (UNEP) in the year (1987) recognized the need to streamline international efforts to protect biodiversity. It therefore established an adhoc working group to investigate "the desirability and possible form of an umbrella convention

to rationalize current activities in the field. This group by 1988 concluded that (a) the existing treaties were inadequate to address the issue of conservation and sustainable use and (b) a new global treaty on biological diversity was urgently needed. Organisations such as the World Conservation Union (IUCN) and the Food and Agricultural Organisation (FAO) contributed draft articles in addition to specific studies commissioned by the UNEP. The UNEP Secretariat prepared the first draft and the formal negotiating process was started in 1991. The Inter-governmental Negotiating Committee for a Convention on Biological Diversity (INC) was given the task of ensuring the adoption of the Convention. On May 22, 1992 the nations of the world adopted the CBD in Nairobi and on June 5, 1992 the CBD was tabled at the UN Conference on Environment and Development in Rio de Janeiro where a record of 150 countries signed the Convention. The Convention on Biological Diversity (CBD) was negotiated and signed by nations at the UNCED Earth Summit at Rio de Janeiro in Brazil in June 1992. The Convention came into force on December 29, 1993. India became a Party to the Convention in 1994. At present, there are 175 Parties to this Convention.

Re-affirming the sovereign rights of Parties over their own biodiversity, the Convention balances conservation with sustainable utilisation and access to and use of biological resources and associated knowledge with equitable sharing of benefits arising out of such use. The CBD offers opportunities to India to realise benefits from its rich biological resources and associated traditional knowledge.

The CBD stipulates that the parties, even though having sovereign rights over their biological resources, would facilitate access to the genetic resources by other parties subject to national legislation and on mutually agreed terms. The CBD also provides for equitable sharing of benefits arising from the utilisation of traditional knowledge and practices, with holders of such knowledge. This has made it necessary for a legislation to be put in place (Biological Diversity Act, 2002, India), which lays down the framework for providing access, for determining the term of such access and for ensuring the equitable sharing of benefits.

Summary of Biological Diversity Act, 2002:

The Biological Diversity Act has 12 Chapters, 65 Sections and many subsections and Rules and Notifications. There are 12 chapters in the act which deals with

- Chapter – I : Preliminary – Terminologies
- Chapter – II : Regulations of access to Biological Diversity
- Chapter – III : National Biodiversity Authority
- Chapter – IV : Functions and Powers of NBA

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- Chapter – V : Approval by the NBA
- Chapter – VII : Finance, Accounts & Audit of NBA
- Chapter – VIII : Finance, Accounts and Audit of SBB
- Chapter – IX : Duties of the Central and State Governments
- Chapter – X : Biodiversity Management Committees
- Chapter – XI : Local Biodiversity Fund
- Chapter – XII : Miscellaneous

Implementation of Biodiversity Act, 2002

A three tiered structure at the National (NBA), State (SBB) and local level (BMC) is envisaged.

National Biodiversity Authority (NBA)

All matters relating to requests for access by foreign individuals, institutions or companies, and all matters relating to transfer of results of research to any foreigner will be dealt with by the National Biodiversity Authority.

State Biodiversity Boards (SBB)

All matters relating to access by Indians for commercial purposes will be under the purview of the State Biodiversity Boards (SBB). The Indian industry will be required to provide prior intimation to the concerned SBB about the use of biological resource. The State Board will have the power to restrict any such activity, which violates the objectives of conservation, sustainable use and equitable sharing of benefits.

Biodiversity Management Committees (BMCs)

Institutions of local state government will be required to set up biodiversity management Committees in their respective areas for conservation, sustainable use and documentation of biodiversity and chronicling of knowledge relating to biodiversity. NBA and SBBs are required to consult the concerned BMCs on matters related to use of biological resources and associated knowledge within their jurisdiction.

Functions and Powers of NBA

- Regulate activities, approve and advice the government of India on research, commercial, bio-survey and bio-utilization.
- Grant approval to Section 3, 4 and 6.

- Certain persons not to undertake Biodiversity related activities without approval of National Biodiversity Authority (Section 3).
- Results of research not to be transferred to certain persons without approval of National Biodiversity Authority (Section 4).
- Application for IPR rights not to be made without approval of National Biodiversity Authority (Section 6).
- Perform such other functions as may be necessary to carry out the provisions of this act.
- Any person who intends to access or apply for a patent or any other form of IPR protection whether in India or outside India referred to sub-section (1) of Section 6 may make an application prescribed by NBA.
- Any person who intends to transfer any biological resource or knowledge associated thereto referred to sub-section (1) of Section 3 shall make an application in such form and in such manner as may be prescribed to the National Biodiversity Authority.
- Determination of equitable benefit sharing by National Biodiversity Authority.

Intellectual Property Rights

Intellectual Property Rights relating to biological resources must be defined in order to ensure that the benefits derived from their use are equitably shared. Section 6 of the Act underlines this principle. In case of persons intending to apply for any form of Intellectual Property Right in or outside India for any invention based on any research or information on a biological resource found in India, prior permission of the NBA is required. The NBA may impose benefit sharing fee or royalty or conditions on the financial benefits arising out of commercial utilization of such right while granting permission. Section 21 provides for the determination of "equitable benefit sharing" which is also one of the objectives of the Act. NBA in consultation with local bodies can impose terms and conditions for securing equitable sharing of benefits.

Biopiracy

To check biopiracy, the proposed legislation provides that access to biological resources and associated knowledge is subject to terms and conditions, which secure equitable sharing of benefits. Further, it would be required to obtain the approval of the National Biodiversity Authority before seeking and IPR based on biological material and associated knowledge obtained from India.

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National Biodiversity Fund

A National Biodiversity Fund is being constituted for this purpose. The NBA will ensure that equitable benefit sharing is made during the utilization of biological resources and the knowledge relating to them. The amount of benefit sharing will be deposited in the National Biodiversity Fund and the amount shall be paid directly to such individuals or groups of individuals or organizations in accordance with the terms of any agreement in such manner as decided by the NBA. On behalf of the Central government, the NBA will take all measures to oppose Intellectual Property Rights granted outside India on any biological resource or associated knowledge originating from India.

Enforcement

The section dealt with under chapter XII provides for enforcement in general and deals with penalty, cognizance of offences, offences by companies, appeal etc in particular. Section 58 provides that the offences under the Act shall be cognizable and non-bailable. Any person, aggrieved by any determination of benefit sharing or order of the Authority under this Act may file an appeal to the High Court. The time allowed to prefer an appeal is 30 days from the date of communication to the aggrieved person of the Order of the Authority. If any person contravenes any direction given or order made by the Central Government, the State Government, the National Biodiversity Authority or the State Biodiversity Board for which no punishment has been separately provided under the Act the person shall be punished with a fine which may extend up to one lakh rupees and in case of a subsequent offence the fine may extend to two lakh rupees and in case of continuous contravention with additional fine which may extend to two lakh rupees everyday which the default continues.

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CONSERVATION OF BIODIVERSITY BY SCHOOL TEACHERS IN LOCAL AREA

Manoj Kumar Sharma*

Introduction

The basic aim of environmental education for the conservation of biodiversity is to succeed in making individuals and communities understand the complex nature of the environment resulting from the interaction of their biological, physical, social, economic, and cultural components. To acquire knowledge, values, attitudes practical skills to save nature, The biodiversity awareness is the prerequisite. Also acquiring more knowledge of biodiversity is the effective way to solve social problems by the management of biodiversity resources.

Environmental education through school teachers help to develop a sense of responsibility as well as accountability among the academic community and improve the global biodiversity by spreading the massage of sustainable life-style among students community.

Biodiversity one of the main life support systems around us is today seriously threatened by the anthropogenic impacts like ignorance, apathy and mismanagement. Better understanding about the biodiversity through the study of non-formal environmental science can improve this situation. Non-formal environmental education through the museums always has a prominent place in the field of biodiversity conservation.

Biodiversity

Biological diversity or biodiversity is the sum total of all living forms on earth. It is the variety and variability of living organism- all species of plant, animals and microorganism and the ecosystem they compose.

History of Conservation

Conservation of biodiversity is essential for the survival of the human life. The world commission on environment and development (WCED) constituted by the general assembly of the United Nations in 1986 provided a major boost and endorsement to the need of conserving the world's biodiversity. In 1992, 'Earth summit' held the auspices of the United Nations Conference on Environment and Development (UNCED) at Rio di Janerio adopted a convention on biological diversity and laid stress on the integration, as far as possible of conservation and sustainable use of biodiversity.

Importance of Biodiversity Education

1. Conservation of biodiversity leads to conservation of life support systems.
2. The genetic diversity of plants and animals need to be preserved for healthy life.
3. This study provides a vast knowledge of potential use to scientific community.
4. Biodiversity conservation serves as an insurance policy for the future.

Environmental Education and Training for Teaching Community

The objectives of environmental education arranged by the UNEP and the UNESCO for teaching community are to:

1. Create awareness and sensitivity to the total environment and its allied problems.
2. Spread the knowledge of the total environment, its associated problems and the responsible presence of humanity in it.
3. Development of the skill to solve environmental problems.
4. Inculcate the ability to evaluate environmental measures and educational programmes in terms of ecological, political, economic, social, aesthetic, and educational factors.

Environmental education can be carried out at many stages – school, college, university and professional level. As per the Supreme Court Order, environmental education has been made as part of curriculum at all stages mandatory.

The important element of environmental education is the training of teachers. The road-map is two folded: 1. the in-service training of college and university teachers, and 2. the pre-service training of teachers joining environmental education.

Formal and Non-formal Training Centres for Teachers

All educational training institutes, included the environmental education as course content in curriculum of D.ED, B.ED, M.ED and L.T level etc.

There are so many non-formal environmental education centers founded by the central as well as state government like the Centre for Environmental Education, Ahemadabad, National Museum of Natural History, New Delhi (NMNH), Regional Museum of Natural History, at Mysore, Bhopal and Bhuvaneshwar are working for awareness for conservation of the environment among the school children, school teachers and the general public through in-service and out-reach

programmes, in-service teacher training programmes, Nature study camps, workshops and lectures related to the environment to create the skills for conservation of biodiversity in local area.

A CASE STUDY : ' Tiger skull as a tool to make awareness among the visitors to save the tiger'

Taxidermy Studio with school teachers

Experiment

The Regional Museum of Natural History, Bhopal have forty skulls and eight tiger skeletons. These are 70-80 years old collections from Mysore. The use of these skulls and skeletons as a tool to the school teachers, children, N.G.Os print media and electronic media to create an awareness of conservation of tigers has been presently attempted. The school teachers, children, NGOs, print media as well as electronic media visited the Taxidermy Studio in the museum. They are giving the massages to the public to save the tiger aiming multiplier effect.

S.No.	Organization	Name of the organization	No. of visitor	Effect
1	NGOs	M.P. Science Centre, Bhopal	120	Multiplier effect
2	School teachers	Carmel convent School, Bhopal	40	,, ,, ,,
3	School children	Carmel Convent School, Bhopal	125	,, ,, ,,
4	Print media	Raj Express, Dainik Bhaskar, Bhopal	02	,, ,, ,,
5	Electronic media	ETV, Bhopal	01	,, ,, ,,

Result

The multiplier effect achieved is understood after studying the response of the on going trials and experiments.

Solution

Priority services for the conservation of biodiversity may be accorded at the earliest by using the available network of local school teachers, students, voluntary groups and local society. It is possible to generate reliable data on biodiversity, involving students at various levels in the exercise as an additional feature.

These programmes are acceptable to generate awareness about the local landscape, their biodiversity changes over time and space. Schools as well as biology teachers should take interest in the local ecological transformation and write about the same in the local media. This leads to general environmental awareness and creation of local society initiative about environmental degradation and its possible control.

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During the regular approach, teaching periods are limited for the teachers and students. Therefore the project work can be undertaken by the learning community during weekends and holidays by spending some time in the local areas like parks, gardens, sanctuaries and museums.

It is also necessary for school teachers to acknowledge that several local communities posses practical knowledge about the biodiversity and ecology of several species in their local areas. Hence teaching community may adopt the "biodiversity register" concept proposed by Prof. Madhav Gadgil.

Following the formula of 'seeing is believing', unless and until the learner community see, touch, and feel the components of biodiversity, they may not be in a position to understand. Hence field visits like visit to garden, farms and museums are suggested.

Some of the areas where school teachers should focus for the conservation of biodiversity in the present 21st century are as follows:

- Appropriate afforestation for conserving biodiversity.
- Promoting the use of alternative fuel to reduce dependence on forests.
- Natural resource sustainability through wild life management and eco-tourism.
- Application of knowledge on rainwater harvesting for use and recharge.
- Using eco-friendly products.
- Reducing pollution, such as air, water, soil etc.
- Organization painting, poster competition, street plays and cultural events to create environmental awareness.
- Formation of eco-clubs to carry out afforestation and other environmental programmes such as nature study camps, eco-tourism etc.
- Increasing the environmental conservation awareness and educational programmes.
- Training involving women and children in the community development and environmental conservation programmes.
- Application of knowledge in biochemistry, applied science and bio-chemical engineering. This subject will play a crucial role in improving the quality of human life
- Self employment in biodiversity related occupation such as eco-park, butterfly farming, apiculture, sericulture, aquaculture etc.

This would enable the teachers and the students to understand their biodiversity and allow them to improve their knowledge fruitfully.

This approach would create a sense of responsibility as well as accountability among the teachers, students and local people. This would also inspire their involvement in monitoring and management of local biodiversity.

Acknowledgement

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CONSERVATION OF BIODIVERSITY AND NATURAL HISTORY MUSEUMS

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ABSTRACT

Conservation of natural ecosystems and their plant and animal inhabitants has a long and complicated history. Modern conservation attitudes and practices have evolved largely within the context of western society, and have been molded definitely by the major political, economic and intellectual revolutions that western society has experienced. These forces continue to shape the practice of biodiversity conservation worldwide.

Bio-diversity Conservation is one of the fastest growing fields of modern scientific research. It is an applied discipline that integrates principles of natural and social sciences with the objective of achieving the long-term persistence of biodiversity on earth.

One of the major requirements for environmental protection and conservation of biodiversity is public participation. The first step in involving public participation is the creation of awareness. Museums, especially the Natural History Museums have a marvelous opportunity with the display techniques, communication strategies and educational activities that museums can develop to play a very significant role in the conservation of biodiversity.

Museums can bring together the different groups of audience as they are the institutions which can transfer information through three dimensional objects, stimulated presentations, etc. which explains the concept to a vide cross section of people by way of non-formal education and active education.

Key words: *Conservation, Bio-diversity, Natural ecosystems, Scientific Research, Public participation, Natural History Museums, Display techniques, Communication strategies, Educational activities, Non-formal Education.*

Introduction

Conservation of natural ecosystems has a long and complicated history. Modern conservation attitudes and practices have evolved largely from the western society, and have been molded definitively by the major political, economical and intellectual revolutions that western society has faced. These forces continue to shape the practice of biodiversity conservation worldwide.

The current global crisis in the loss of biodiversity is the result of the immense success of human beings. Concern about the loss of biodiversity arises from spiritual, moral and aesthetic motives through economic rationales to purely selfish reasons.

The mandate of Biodiversity conservation covers a spectrum that runs from concern about the conservation of large, intact, functioning ecosystems, through the maintenance of viable indigenous human and ecological communities to the preservation of the last surviving individuals of species in zoos and botanical gardens. The discipline of bio-diversity conservation has arisen from the need to apply science to the protection of species that are threatened or on the brink of extinction.

Bio-diversity Conservation is one of the fastest growing fields of modern scientific research. It is an applied discipline that integrates principles of natural and social sciences with the objective of achieving the long-term persistence of biodiversity on earth.

The biodiversity crisis has stimulated the emergence of this new field by bringing scientists from ecology, systematic biology and wildlife management together with environmentalists to seek ways to preserve, restore and manage biodiversity.

What is Bio-diversity?

The term "Bio-diversity" was first used in its long version "Biological Diversity" by Lovejoy (1980) and is commonly used to describe the range of life forms on the Earth. The Convention on Biological Diversity (CBD Article 2) states that:

"Biological diversity" means the variability among living organisms from all sources including, inter alias, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part, this includes diversity within species, between species and of ecosystems.

Biodiversity is the variety of life, it includes millions of plants and animals from micro level to macro level, the genes they contain and the intricate ecosystems of which they are a part.

Elements of Biodiversity

The basic building blocks of biodiversity are:

1. Genetic Diversity
2. Species Diversity
3. Ecosystem Diversity

Genetic Diversity

It refers to the variation of genes within the species. This constitutes distinct population of the same species or genetic variation within population or varieties within a species.

Species Diversity

It refers to the variety of species within a region. Such diversity could be measured on the basis of number of species in a region.

Ecosystem Diversity

Ecosystem diversity could best be understood if one studies the communities in various ecological niches with in the given ecosystem; each community is associated with definite species complexes. These complexes are related to composition and structure of biodiversity.

Biodiversity at different levels

Global level

It is estimated that 5-30 million species of living forms exists on our earth, of which only 1-5 million have been identified which includes 3,00,000 species of green plants and fungi, 8,00,000 species of insects, 40,000 species of vertebrates and 3,60,000 species of microorganisms.

The tropical forests are regarded as the richest in biodiversity. According to the opinion of the scientists more than half of the species on the earth live in moist tropical forests, which is only 7% of the total land surface area.

Country level

India has tremendous variety of biodiversity. This richness in biodiversity is due to various climatic and altitudinal conditions coupled with varied ecological habitats. These vary from the humid tropical Western Ghats to the hot desert of Rajasthan, from the cold desert of Ladakh and the icy mountain of Himalayas to the warm coasts of peninsular India.

In India, about 1,15,000 species of plants and animals have been identified and described. It includes 45,000 plant species and 81,000 species of animals.

Loss of Biodiversity

Population growth, growing demand for fuel wood, other forest products, pollution due to industrialization and a market for rare animals and plants have all threatened the biological diversity in the present day. One of the major causes for the loss of biological diversity in India is the depletion of vegetative cover in order to expand agricultural practices.

Biodiversity Conservation

The conservation of biodiversity is always linked with maintenance of ecological stability and productivity. These are important in sustained development and stable national economy. Biodiversity conservation involves a number of parameters such as number of species, their population dynamics, distribution, habitat, structure, microhabitats, physical environment, climate, present management and past history. Therefore the effort for conservation of biodiversity should be from micro level to macro level.

Also biodiversity is the variety and variations occurring in nature, which has sustained the harmonious existence of life on earth. The components of this diversity are so interdependent that any change in the system leads to a major imbalance and threatens the normal ecological cycle.

The Convention on Biological Diversity (CBD) was signed at the Earth Summit held at Reo de Janeiro in June 1992. The CBD is the first treaty for the conservation of biodiversity. This convention entered in to force on 29th December 1993. At present 166 countries are the parties to the convention. The international treaty reflects the commitment of global community for conservation and sustainable use of biodiversity.

The main objectives of the convention are

1. The conservation of biological diversity
2. The sustainable use of biological diversity
3. The fair and equitable sharing of benefits arising out of the utilization of genetic resources.

India was the first country to sign the CBD and the 48th to ratify it, in February 1994. The provisions on in-situ and ex-situ (Article 8 and 9 of CBD) conservation could provide a renewed thrust to wildlife protection through National Parks, Wildlife Sanctuaries, National Monuments, Cultural Landscapes, Biosphere Reserves etc. and a new direction to agriculture.

Natural History Museums in Biodiversity Conservation

One of the major requirements for environmental protection and conservation of biodiversity is public participation. The first step in involving public participation is the creation of awareness. The convention on Biological Diversity's 13th Article suggests the public education and awareness. Museums, especially the Natural History Museums have a marvellous opportunity with the display techniques, communication strategies and educational activities that museums can develop to play a very significant role in the conservation of biodiversity.

Museums can bring together the different group of audience as they are the institutions which can transfer information through three dimensional objects, stimulated presentations, etc. which explains the concept to a wider cross section of people by way of non-formal education and active education.

Museums also have a unique facility to store objects and information that may help in the future reference. Our concern with our present needs are to be linked with the past, to extrapolate for future. The environmental changes that have taken place in the course of years could be shown through museum exhibits. For the effective understanding of the process of progress/degeneration museum exhibits helps a lot. Therefore the Natural History Museums play a useful role to create awareness in the conservation of biodiversity to the public.

Permanent Exhibit Galleries

Natural History Museums have the thematic exhibits on ecosystems, habitats, inter-relationship of plants and animals, food chain, food web, endangered species, pollution, waste management, recycling, water, climate change, energy conservation, ozone depletion, population, deforestation, Global warming and conservation action plans. It provides a unique opportunity to explore the natural world, diversity of plants and animals, biodiversity of the country as well as the intricate network of nature around us.

Temporary Exhibitions

From time to time the Natural History Museums organize exhibitions of temporary nature on different themes to create awareness among the masses. The exhibitions like Endangered Animals of India, Mammals of India, Birds of India, Biodiversity of India, You and your environment, Snakes are not our enemies, Water is life, etc. educate and create awareness for the various sectors of visitors. The rich biodiversity of our country and the importance to conserve the biodiversity, its sustainable use and to preserve for the future generation, are also adequately provided through display of objects.

Outreach Programmes

(a) Field Trips to Nature Reserves

Natural History Museums plays a leading role in the development of outreach programmes in the form of educational field trips. National Parks, Wildlife Sanctuaries, and Biosphere Reserves are excellent areas for promoting awareness about biodiversity conservation. Interpreting nature in its natural setup is the best suitable method to create awareness. These Nature Reserves can act as "living laboratories" and they can be the excellent combination for imparting public education and awareness about biodiversity and its conservation.

The National Parks, Wildlife Sanctuaries, and Biosphere Reserves has enormous potential to undertake variety of educational activities relevant to promote an understanding of nature, natural history, ecology, conservation etc. The goal should be to formulate quality education programmes, especially for the students, youths and public to develop awareness, knowledge and constructive action in protecting our biodiversity.

(b) Mobile Museum

A specially designed vehicle, equipped with exhibits and Audiovisual materials visiting rural areas and with its exhibitions for the rural people is useful. These Mobile Museums provide an avenue for them to know about our rich biodiversity and the need to conserve it. During the day time the Mobile Museum creates awareness through its exhibits set it can screen some wild life films to create awareness about the biodiversity and its conservation.

(c) Mobile Exhibitions

Mobile exhibitions on various themes can be prepared on panel and display to create awareness in the areas where the mobile museum could not be placed. These panels could easily to be assembled and dismantled. Package in small boxes makes transportation easy. The exhibitions could be arranged in collaboration with the local people/agencies.

Publications

Natural History Museums provide publications to assist the visitors to understand the exhibits and get the maximum information.

Besides, Guide books with details of the museum exhibits like ecosystems, habitats, interrelationships between plants and animals, endangered species, pollution, waste recycling, water, climate change, energy conservation, ozone depletion, population, deforestation and Global warming are prepared and distributed to the visitors.

Brochures about the theme of the Temporary Exhibitions.

Booklets about the National Parks, Wildlife Sanctuaries and Biosphere Reserves.

Booklets about the extinct, endangered species of flora and fauna.

Booklets about the Conservation Strategies and plans of the Government.

Picture post cards of wild plants and animals can also be prepared and distributed to public.

Recent achievement of biodiversity conservation by the National Museum of Natural History

The National Museum of Natural History in collaboration with the Wildlife Trust of India and the Arunachal Forest Department has taken initiative to save the most endangered species of Hornbill birds.

The Arunachal Pradesh contains tropical rain forests with rich biodiversity. There are many tribal people living in the forests and they depend on the forest for their food, shelter etc. Nyshis are the important tribes of this forest area. They use many animal parts for their traditional dress and headgear. They traditionally use the hornbill beak as headgear. For this purpose they kill the hornbill species of that forest. Because of this the hornbill population decreased drastically in this area. It is a known fact that hornbills are good nutcrackers and seed dispersers.

To prevent the killing of hornbill the forest department officials convinced the tribal people to use artificial beaks instead of original hornbill beaks and supplied wooden beaks through the Wildlife Trust of India in the beginning and latter supplied the fibreglass beaks.

The Wildlife trust of India tied up with National Museum of Natural History, New Delhi to train the local people in fibreglass beak making. A three member NMNH team visited Arunachal Pradesh and provided training to twenty local people in the fibreglass hornbill beak making.

This is an example, to show how the natural history museums could interact with the people about the conservation of biodiversity.

Conclusion

Natural History Museums are excellent resource centers for the conservation of biodiversity. These Natural History Museums not only help in providing the information regarding the surroundings but also create an interest to have a deeper knowledge about the environment which would lead to the effective use of resources and the preservation of the natural wealth for the future posterity.

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II. ALGAL BIODIVERSITY

ALGAL BIODIVERSITY OF TAMIL NADU

M. Baluswami

Algae are simple photosynthetic organisms, used by civilizations from ancient time. They are used as food, source of vitamins, minerals and contain substances that are of pharmaceutical importance, possess pigments that are used as food colourants and provitamin A. These are the only source of polysaccharides such as agar, alginate and carrageenan. While a small number of algae are exploited for obtaining the above said substances a large number of algae are left without even being documented. Of 40,000 species of algae reported around the world, India is reported to have 6500 species of which Tamilnadu hosts only 1288. Information on algal flora of Tamilnadu is scattered in several monographs, numbering around 10 and as scientific publications in journals. All the monographs are world monographs and bear only a few algal taxa from Tamilnadu. These records are also from only a few places of Tamilnadu and majority of the area of Tamilnadu is left untouched. Recent investigations of several researchers on this group have resulted in documenting many unreported taxa. As of now the algal flora of Tamilnadu includes 1288 taxa. This comprises a total number of 676 taxa of freshwater algae, 641 taxa of marine algae and 17 taxa of algae from salt plans. The freshwater algae are distributed in different habitats of higher altitudes and plains. Most of the freshwater algal habitats from which algae are recorded have disappeared now or disappearing fast due to the developmental activities and irregular rainfall patterns. The Tamil Nadu Government's initiative to reclaim freshwater bodies in and around Chennai and other places of Tamil Nadu is a welcome step as it would maintain the water bodies free of pollution and encroachments there by providing a favorable environment for freshwater algae. The marine algae are also under severe strain due to human activities and natural calamities. If these algae are not documented at least now, there is every possibility of loosing them without even knowing them and their potential.

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DIVERSITY OF PHYTOPLANKTON IN AND AROUND PARYAVARAN PARISAR AT LAKE CITY BHOPAL

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ABSTRACT

'Plankton' is a collective term for organisms adapted specifically for a life passed mainly in suspension in the open water (the Pelagic zone) of the sea and of such inland waters as lakes, reservoirs and rivers. Plankton contributes to the maintenance of high biological diversity in individual habitats and to the survival of high species richness among planktonic assemblage in general.

Phytoplankton have the capacity for photoautotrophy, the ability to manufacture organic carbon compound through the photosynthesis by reduction of carbon dioxide and it is the sole distinguishing criterion for separating them from other planktonic organisms.

Paryavaran Parisar is located in the New Bhopal area and just adjacent to the E-5 Arera Colony. There are many offices situated in this parisar like the Environmental Planning and Coordination Organisation (EPCO), Madhya Pradesh Pollution Control Board, World Wide Fund for Nature (WWF), Centre for Environmental Education (CEE), Lake Conservation Authority (LCA), Disaster Management Institute (DMI), Regional Museum of Natural History (RMNH), etc. Most of these offices are working for the common interest i.e. Environment.

Only one water reservoir facing RMNH is situated in the Paryavaran Parisar, while Shahpura Lake flanked with its two sides. Reservoir facing RMNH is filled with the treated water, while Shahpura Lake carries drainage and sewer of New Bhopal, which comes through the Panchsheel Nallah.

Samples of phytoplankton were collected from the junction of Panchsheel Nallah & Shahpura Lake, Near Manisha Park, outlet of Shahpura Lake and reservoir facing RMNH. These samples were studied in the laboratory to identify the ***Diversity of Phytoplankton in and around Paryavaran Parisar at Lake City Bhopal****.*

Key Words: *Phytoplankton, Pelagic zone, Photoautotrophy, Diversity, Organic Carbon Compound, Photosynthesis.*

Introduction

All life forms exist in the biosphere comprised of lithosphere, atmosphere and hydrosphere. Largest number of lives are inhabited in the various forms of hydrosphere such as lake, river, ocean etc. These lives can be divided in to phytoplankton including other algae, zooplankton, nematodes, fishes, reptiles, mammals etc. Phytoplankton forms the base of the aquatic food chain; larger organisms graze on the phytoplankton, still larger creature eat the grazers, and so on. The present effort is an attempt to study the phytoplanktonic species diversity of the non-polluted water reservoir and polluted lake.

As understood from the available literature any water body which has more species of bacillariophyceae and *Cyanophyceae*, that water body is said to carry polluted water. When more chlorophyceae members are present in a water body, it could be relatively called as non-polluted or less polluted water. Generally weather, temperature, intensity of light and nutrients also influence the phytoplanktonic diversity of water body.

Objective

This study is important because

- No such study has been carried out in Indian museums, especially in Madhya Pradesh.
- Important to maintain the level of pollutants in water bodies located in public institutions like museums.
- To create awareness about water polluting algae.
- To use as 'Live Corner' of museum.

Plankton

The term 'plankton' was coined by Victor Henson in 1887. 'Plankton' is a collective term for organisms adapted specifically for a life passed mainly in suspension in the open water (the pelagic zone) of the sea and of such inland waters as lakes, reservoirs and rivers. Plankton term has been confined to designate only the microscopic, free floating organisms, which depend on their nature. Plankton contributes to the maintenance of high biological diversity in individual habitats and to the survival of high species richness among planktonic assemblage in general. Plankton can be divided in two major groups, namely: *Phytoplankton* and *Zooplankton*.

Phytoplankton

Microscopic autotrophs suspended plants are called as phytoplankton (Phyto=Plant, Plankton=Floating). It is a free floating, algae imparting a colour to the water body. Phytoplankton contains chlorophyll and require light, to manufacture organic carbon compound by photosynthesis through reduction of carbon dioxide. It is the sole distinguishing criterion for separating them from other planktonic organisms.

Majority of the phytoplankton belongs to the class *Chlorophyceae*, *Bacillariophyceae* and *Cyanophyceae*, while a few of the phytoplankton belongs to *Euglenophyceae* and *Dinophyceae*.

An excess of the nutrients such as nitrogen, iron and phosphate pollutant helps in the rapid growth of phytoplankton, which is called as **Bloom**. During a bloom, phytoplankton can be abundant that only 1cubic foot of water contains more than thirteen million (1,30,00,000) organisms.

The phytoplankton is extremely diverse. More than 4000 species of marine phytoplankton have been named and described (Sournia et al, 1991). Fresh water phytoplankton are estimated to contain nearly 4000 species (Reynolds, 1996). The oxygen, the phytoplankton produces is equally important to life. Perhaps 50-70% of the earth's atmospheric oxygen comes from unicellular marine algae.

"Without *algae* it is doubtful that man could have evolved and survived. Indeed, many biologists believe that one-celled algae (phytoplankton) may have been the remote ancestors of all multi-cellular organisms"

Writes Zahl (1974)

About Paryavaran Parisar, Bhopal

Paryavaran Parisar is located in the New Bhopal (capital city of Madhya Pradesh) area and just adjacent to the E-5 Arera Colony. There are many offices situated in this parisar like Environmental Planning and Coordination Organisation (EPCO), Madhya Pradesh Pollution Control Board, World Wide Fund for Nature (WWF), Centre for Environmental Education (CEE), Lake Conservation Authority (LCA), Disaster Management Institute (DMI), Regional Museum of Natural History (RMNH), etc. Most of them are working for the common interest i.e. Environment.

Only one water reservoir facing RMNH is situated in the Paryavaran Parisar, while paryavaran parisar is flanked by Shahpura Lake. Reservoir facing RMNH is filled with the treated water i.e. non-polluted water, while Shahpura Lake carries drainage and sewer i.e. polluted water of New Bhopal, which comes through the Panchsheel Nallah.

Sampling method

Samples of phytoplankton were collected at 4.00 p.m. from the junction of Panchsheel Nallah & Shahpura Lake, Near Manisha Park, outlet of Shahpura Lake and from the reservoir facing RMNH. These samples were collected by filtering two litres of water through a plankton net of fine bolting silk (size: 42 micron) and concentrated to 50 ml.

Analysis

There is no stain, chemical or preservative used for the study of sample. One ml. of the sample was thoroughly scanned under Lieca Image analyzer.

Results

Total 08 species (Table 1) of phytoplankton were identified from non-polluted water reservoir, out of which 13% species belong to the *chlorophyceae*, 62% *bacillariophyceae* & 25% *cyanophyceae*. While 017 species (Table 1) of phytoplankton were identified from polluted water reservoir, out of which 35% species belong to the chlorophyceae, 53% bacillariophyceae & 12% cyanophyceae.

No abnormality was noticed in size, shape or structure of any of these species. *Microcystis aeruginosa* was the dominant species while *Tabellaria* was found to be the subdominant species in the sample collected from RMNH facing reservoir. Similarly in the samples collected from Shahpura Lake the *Pinnularia sp* found to be the dominant one. Here the co-dominant species was found as *Tabellaria sp* and the *Naviculla sp* found to be subdominant.

Table: 1 Phytoplankton species of non-polluted water reservoir i.e. reservoir facing RMNH and polluted water reservoir i.e. Shahpura Lake (January 2006).

Class	Reservoir facing RMNH	Shahpura Lake
Chlorophyceae	*Cosmarium sp*	*Chlorella sp* *Selenastrum sp* *Cosmarium sp* *Scenedesmus armatus* *Scenedesmus obliquus* *Scenedesmus quadricauda*
Bacillariophyceae	*Pinnularia sp* *Tabellaria sp* *Synedra ulna* *Cymbella sp* *Achnanthes sp*	*Navicula sp* *Melosira sp* *Nitzchia sp* *Diatomella sp* *Cymbella sp* *Achnanthes sp* *Pinnularia sp* *Tabellaria sp* *Cyclotella sp*
Cyanophyceae	*Microcystis aeruginosa* *Spirulina sp*	*Microcystis aeruginosa* *Oscillatoria sp*

Discussion

It is a preliminary work to prepare a check-list of phytoplanktonic diversity of paryavaran parisar at lake city Bhopal. Other aspects of water body like biomass of phytoplankton, physico-chemical nature of water, BOD, COD etc. can be done on later.

Physico-chemical characteristic have a strong controlling influence on lake diversity. Any change in the habitat by way of external influences has great influences on the biodiversity of the water body. Thus bilodiversity of a water body is often considered as an effective tool for evaluating the trophic status of a water body. Phytoplankton communities are often dominated at a time by one or smaller species (e.g. *Microcystis aeruginosa*), most of which exhibit short growth periods restricted to a fairly precise season, nutrient availability and predation pressure (Pani & Mishra, 2000).

It has been observed that the nutrient rich sites have the richest phytoplanktonic diversity and nutrient less have the poorest of the poor. Chlorophyceae members are a nutrient rich phytoplankton, which is commonly used for fish food preparation. Chlorophyceae and bacillariophyceae members are eaten by zooplankton in the habitat. Small fishes feed on cyanophyceae members, except *Microcystis*.

Limitations

Systemic, periodical and seasonal study will reveal more information in the said report. Identifying of phytoplankton is a time consuming process. The study may be completed after years of dedication towards this work. But this effort was done only once in the month of January 2006. Hence, there are possibilities that all species of both the water bodies could not be represented in the collected sample.

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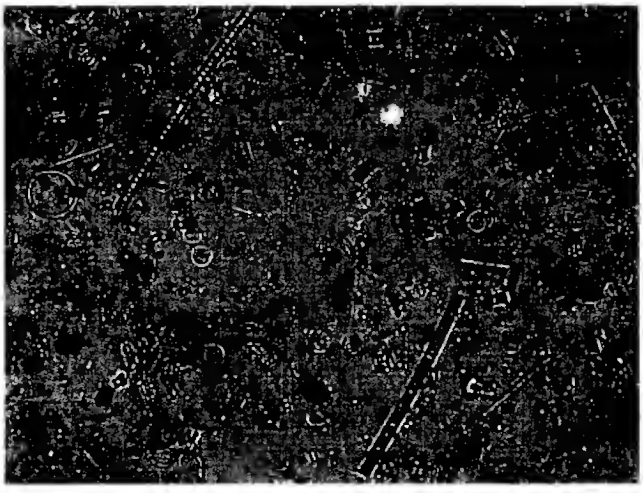
DIVERSITY OF PHYTOPLANKTON

Plankton net and sampling bottles

Lieca image Analyzer



A drop of water as seen under Lieca image analyzer

Tabellaria sp and Pinnularia sp.

A STUDY OF BIODIVERSITY OF ALGAE FROM THE TEMPLE TANKS IN AND AROUND THE CITY OF CHENNAI

S. Chandra*

ABSTRACT

Temple tanks are prime source of water storage since ancient times. There are about Fifty identifiable temple tanks in and around the city of Chennai, most of them today are neglected, disused or being used as dump garbage, seepage, or sewage or as open air toilet. Some tanks are well classified into three types. Tanks reasonably well maintained and in use, tanks not well maintained but still in use, tanks badly maintained either serving as garbage dump, or covered with overgrowth or both, however most of the tanks belonged to this category. The water samples were collected from tanks and their physical parameters such as humidity, temperature, water pH were recorded. Water was analyzed for its basic nutrients such as nitrogen, phosphorous, potassium COD and BOD. The hydrological features revealed that the tanks were part of an integral water harvesting system and were situated in the basin of one of the rivers that flowed through the city. Unplanned channels that fed the tanks, the water by passes these tanks on its way to sea. The water samples have been collected from several tanks, such as 1. Dhandeeswarar temple, Velachery 2. Maruntheeswarar temple, Thiruvanmiyur 3. Kabaleeswarar temple, Mylapore 4. Parthasarathy temple, Triplicane 5. Karuneeswarar temple, Saidapet 6. Jagannatha perumal temple, Thirumalizai 7. Vaidheeswarar temple, Poonamalle 8. Adhikesava perumal temple, Chindadripet 9. Velveswarar temple, Valasaravakkam 10. Kandakottam, Parrys.

The study of biodiversity of algal forms were carried out. In this study, algae belonging to different classes such as Cyanophyceae, Chlorophyceae, Bacillariophyceae, Eugenophyceae were recorded. Individual cell count was done using haemocytometer. Nygaards phytoplankton quotients and water quality criteria for indicating oligo trophic/ eutrophic status was also carried out. The biodiversity studies indicate that these water bodies are in the state of eutrophication because of poor maintenance as most of these tanks are in a state of misuse, disrepair, dump garbage or even as open air toilet, which leads to increase in algal population i.e. eutrophication. Due to eutrophication, there would be enrichment of nutrients in the water and this enrichment could either be organic or inorganic enrichment. Public should be educated about the importance of freshwater bodies and strict rules should be enforced to keep the water body clean which would certainly add glory to the tanks at least in the near future.

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Introduction

Rivers of Southern India are only rain fed. The river fed states compete for river water, and have put up dams for their own needs. The most suitable example is river cauvery. The states do not have proper agreement in utilizing the water, that made water management a critical problem which could even spoil the harmony of people belonging to different states of India.

Non availability of river water and consequent failure of rains led to the water harvesting and storage system; this includes percolation ponds, natural lakes, artificial reservoirs and temple tanks. There are at least fifty identifiable temple tanks in and around the city of Chennai. Tanks were used as water harvesting system and they were classified into four namely 1. Percolation ponds 2. Natural lakes 3. Artificial Reservoir 4. Temple tanks. Chennai, a city with two east flowing rivers namely river Adayar, and river Coovum, temple tanks and earthen reservoirs were dug along river basin. These reservoirs are interconnected with channels that took the overflow of one to another. Prior work on biodiversity of Algae in temple tanks were carried out by Iyengar (1939), Ganapathi, (1940), Jeeji Bai, N. and Lakshmi (1999), Maya.S. (2003).

Present status of temple tanks

Chennai and its suburban have more than fifty temple tanks to harvest rain water. Temple and their tanks are built in such a way that they fall in the basin of either of the two rivers or are very close to huge earthen reservoirs such as lakes or ponds. These reservoirs are connected with channels that took the overflow of one to another. Unplanned urbanization has blocked the storm water channels that fed the tanks; the water now flows into the sea, bypassing the tanks (Amirthalingam and Muthukrishnan, 2004). In recent times temple tanks have fallen into disrepair, misuse and most of them are used as dump garbage, or open air toilet.

Ten temple tanks of Chennai and its suburban area were studied for their current status and algal biodiversity (Table 1)

1. Dhandheeshwarar temple, Velachery
2. Maruntheeswarar temple, Tiruvanmiyur
3. Kabaleeshwarar temple, Mylapore
4. Parthasarathy temple, Triplicane
5. Karuneeshwarar temple, Saidapet
6. Jaganatha Perumal Temple, Thirumalisai
7. Vaidheeswarar temple, Poonamalle
8. Adhikesavar perumal Temple, Chindathripet
9. Velveswarar temple, Valasarawakkam
10. Kandakottam, Parrys.

Materials and Methods

The water samples were collected, filtered and concentrated using standard methods. The physico chemical parameters such as temperature, pH, humidity, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and the routine chemical test analysis for various essential nutrients were carried out using standard procedures (Table2). The algae were identified using standard manuals (Table 1). Individual cell counts were made in the tank samples using Haemocytometer. The trophic level of water of the tanks was analysed with the help of Nygaard's Index (table 4).

Results and Discussion

In the present investigation a total number of thirty species of fresh water algae belonging to Cyanophyceae, *Chlorophyceae, Bacillariophyceae* and *Euglenophyceae* were recorded.

Out of forty three species, 9 species belonged to *cyanophyceae*, 12 species belonged to *chlorophyceaë*, 6 species belonged to *bacillariophyceae* and 3 species belonged to *Euglenophyceae*, which shows that *Cyanophyceae* was dominant *Chlorophyceae* and *Bacillariophyceae* were sub dominant and few *Euglenophyceae* were also reported. The list of various algae encountered in the study is given in Table 1.

TABLE 1 SHOWING ALGAL BIODIVERSITY

Algal Biodiversity	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**
CYANOPHYCEAE										
Microcystis aeruginosa	+	+	+	-	+	+	+	-	+	+
Chroococcus Sp	-	-	-	+	+	-	-	-	+	+
Oscillatoria Sp	-	+	+	+	+	+	+	+	+	+
Anabaena Sp	-	-	-	-	+	+	+	-	+	+
Spirulina Sp	-	-	-	+	-	-	+	-	-	-
Schizothrix sp	-	+	-	-	-	-	-	+	+	-
Gomophosphaeria aponina	-	+	-	+	-	-	-	+	-	-
Merismopedia aeruginosa	-	+	-	+	-	-	-	+	-	-
Anabaenopis arnoldii	-	-	-	-	-	-	-	+	-	-

CHLOROPHYCEAE										
Spirogyra longata	-	-	-	-	-	-	-	+	-	-
Spirogyra Sp	-	-	+	-	-	-	-	+	-	-
Scenedesmus quadricauda	+	-	+	+	-	+	+	-	-	+
Scendedesmus bijugatus	-	-	-	-	+	-	-	-	+	-
Scenedesmus acuminatus	+	-	-	-	-	-	-	-	-	-
Pandorina Sp	-	-	+	+	-	-	-	-	-	-
Selenastrum	-	-	-	-	-	+	-	-	-	-
Ankstrodesmus falcatus (corda) Rath	-	-	-	+	-	-	-	-	-	-
Pediastrum duplex	-	-	-	+	-	-	-	-	-	-
Pediastrum tetras	-	+	-	-	-	+	-	-	-	-
Cosmarium sp.	-	+	-	+	-	-	-	+	-	-
Closterium ehrenbergii	-	+	-	+	-	+	-	+	-	+
BACILLARIOPHYCEAE										
Pinnularia Sp.	-	+	+	+	+	+	-	+	-	+
Gomphonema Ap.	-	+	+	+	+	+	-	+	+	+
Amphora Sp.	-	-	+	-	+	-	-	-	+	-
Pleurosigma Sp.	-	-	+	-	-	+	-	+	-	-
Fragillaria Sp.	-	-	-	-	+	-	-	-	-	-
Navicula	-	-	-	-	-	-	-	-	-	+
EUGLENOPHYCEAE										
Euglena Sp.	+	-	-	-	-	+	-	-	+	-
Phacus Sp.	+	+	+	+	-	+	-	-	+	-
Lephocinclis acuta	-	-	-	+	-	-	-	+	-	-

The pollution tolerant algae such as *Oscillatoria*, *Spirogyra*, *Scenedesmus*, *Pinnularia*, *Gomphonema*, *Euglena* (Palmer C.M.1963) were present in these tanks can be taken as bio indicator of pollution.

The physico chemical parameters are represented in table 2, the atmospheric temperature was in range of 30 to 31°C, water temperature ranged from 27 to 29°C, humidity ranged from 84 to 86%, pH ranged from 7.37 to 9.19.

BOD ranged between 8.4 to 81, mg/L. COD ranged from 22.61 to 260.06 mg/L Nitrate ranged from 0.07 mg/L to 7.5mg/L, phosphate from 0.64 to 2.46 mg/L, potassium from 20 to 147

mg/L. Since the BOD, COD and essential nutrients are in appreciable amounts in all the ten tanks, it is very clear that these water bodies tend towards eutrophication. There is high dissolved mineral content especially nitrates, phosphates, potassium in one of the tanks i.e. Vaidheeswara temple, Poonamalle. Potassium was found to be 147 mg/L indicating that the water is highly polluted.

The results of total cell count of by Haemocytometer shown in Table 3.

TABLE 3 INDIVIDUAL CELLCOUNT USING HEAMOCYTOMETER

Cell count	Tank 2	Tank 4	Tank 6	Tank 8	Tank 10
Chroococcus sp			2000	4000	
Microcystis aeruginosa Kutz	1500000	100000	20000	80000	12000
Gomphosphaeria aponina Kutz	50000				30000
Merismopedia convolute Breb	28000		50000		16000
Schizothrix lamyi			1000	1000	
Oscillatoria sp.	30000	50000	42000	7000	3000
Spirulina princeps West	2000	2000			
Anabaena sp		20000			18000
Anabaenopsis arnoldi	30000			18000	
Chlorophyceae					
Pandorina Sp			8000		
Selenastrum Sp.					8000
Ankistradesmus falcatus (corda) Rath	7000				
Pediastrum duplex Meyen		30000		30000	
Pediastrum tetras	8000		4000		
Scenedesmus quadricauda (turp) Breb		4000		4000	4000
Scenedesmus acuminatus (Lagerh)	8000				
Spirogyra longata Vauch				20000	
Cosmarium sp	2000	4000		20000	
Closterium eherenbergii Menegh	5000	7000	4000	4000	4000
Lepocinclis acuta				80000	9000
Phacus Sp	10000	9000	2000	80000	5000
Euglena Sp.					8000
Bacillariophyceae					
Pleurosigma sp				5000	7000
Pinnularia sp.		7000	6000	15000	10000
Navicula sp.					1000
Gomphonema sp	7000	7000	3000	4000	1000

The results of Nygaards index indicating the trophic level of the water bodies are presented in Table 4. These five tanks show eutrophic state. This is because of the presence of only two desmids (*Cosmarium sp.* and *Closterium ehrenbergii*) in the current collection. The abundance and biodiversity of algae in all temple tanks can be correlated with the eutrophication. This generally leads to increase in the algal population as there would be enrichment of nutrients in the water. This enrichment could either by organic or inorganic enrichment.

Table 4. Nygaards phytoplankton quotients and water quality-criteria for indicating oligo tropic/eutropic state

Index		**Oligitrophic**	**Eutrophic**
Myxophycean	*Myxophycean/Desmidiaceae*	0.0-0.4	0.1-3
Chlorophycean	*Chlorococcales/Desmididaceae*	0.0-0.7	0.2-9
Diatom	*Centric diatom/Pennate diatom*	0.0-0.3	0.0-1.75
Euglenophyceae	*Euglenophyceae/Myxophyceae +Chlorococcales*	0.0-0.2	0.0-1.0
Compound	*Myxophyceae+Chlorococcales +Centric diatoms+Euglenophyceae /Desmidiaceae*	0.0-1	1.25-2.5

Index	**Tank 2**	**Tank 4**	**Tank 6**	**Tank 8**	**Tank 10**
Myxophycean	2	3	2	3	2
Chlorophycean	2	1	2	1	1
Diatom	0	0	0	0	0
Euglenophyceae	2	3	0.4	0.5	1.1
Compound	6	6	3	4	3

Conclusion

These water bodies tend towards eutrophication because of poor maintenance as these tanks are often in a state of misuse, need for repairs, dumping of garbage, or even misusing them as open air toilets. Hence it is necessary that the public should be educated about the importance of fresh water bodies. Strict rules should be enforced to keep water body clean which would certainly add glory to the tanks at least in the near future.

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III. ANGIOSPERM DIVERSITY

ANGIOSPERM SPECIES DIVERSITY

GLOBAL, NATIONAL AND REGIONAL SCENARIO

D. Narasimhan, C. Chandrakala, A.K. Rathnakumari & C.K. Sathya

ABSTRACT

Angiosperms form the second most speciose group among the living organisms next to insects. The Earth contains about 2,62,000 described species of angiosperms. Much of the Angiosperm species diversity is located in tropical regions such as Latin America, Africa and South Asia. Some of the most speciose families of the world include Compositae, Orchidaceae, Leguminosae, Rubiaceae and Graminae.

India alone harbours 6.4% of the total world's angiosperm species. A total of 16,809 species are reported to occur in India excluding the subspecific taxa. Among the different states of India, Tamil Nadu is the most speciose state with about 5,198 species. This richness in species diversity of Tamil Nadu can be attributed to the rich diversity of habitats from hot and humid coastal plains to high altitude montane regions.

More than 1/3 rd of the species distributed in India are endemic to India. These endemic species are distributed in three regions namely, Western Ghats, North Eastern India and Eastern Himalayas. These regions form a major part among the three currently recognized Hotspots of Biodiversity namely Western Ghats and Sri Lanka, Indo-Burma and Himalaya. Families such as Lauraceae, Umbelliferae, Ranunculaceae, Rosaceae and Balsaminaceae show a high degree of endemism in India.

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Introduction

Angiosperms form the second most speciose group among the living organisms next to insects. This group is also the best documented group among the different living organisms. Documentation in several groups of organisms such as bacteria, fungi, insects and viruses is far from complete. In these groups of organisms what is known to science (described species) is much less than what is to be known by science. Much of the Angiosperm species diversity is located in tropical regions of Africa, America, Asia and Australia. Twenty-five most plant rich countries such as Brazil, Cameroon, China, Colombia, India, Indonesia, Madagascar, Malaysia, Mexico, Peru, Tanzania, Thailand, Venezuela and Zaire of the world occur in these regions (Akeroyd, 1992).

The Earth contains about 2,49,300 described species of angiosperms under 13,114 genera, distributed in 405 families (Mabberley, 2005). However, the estimates of the number of flowering plants vary between 2,40,000 to 7,50,000 (Akeroyd and Synge, 1992). It is quite difficult to affirm a definite number as we do not have a complete information on floras of several tropical countries. Nearly 44 % of Angiosperm species diversity of the world is distributed within 10 families (Table 1).

Table 1: TEN MOST SPECIOSE FAMILIES OF THE WORLD

S. NO.	FAMILY	NO. OF GENERA	NO. OF SPECIES
1	*Asteraceae*	1,528	22,750
2	*Orchidaceae*	788	18,500
3	*Leguminosae*	643	18,000
4	*Rubiaceae*	630	10,200
5	*Poaceae*	668	9,500
6	*Euphorbiaceae*	313	8,100
7	*Lamiaceae*	251	6,700
8	*Scrophulariaceae*	268	5,100
9	*Melastomataceae*	188	4,950
10	*Liliaceae*	288	4,950

Source: Mabberley, 2005

Estimates of Angiosperm species in India vary between 15,000 and 17,000. A recent estimate by Karthikeyan (2000) concludes that a total of 16,809 species occur in India and when the subspecific taxa such as subspecies and varieties are included the total number of taxa increase to 19,395 (Table 2).

However, most people fail to distinguish between species and taxa when it comes to total number. This ambiguity is also partly a reason for varied estimates of angiosperms. Nearly 45% of the flowering plants in India are distributed in ten families (Table 3). A close look at these families shows that the first seven families dominate both globally and nationally in a differential order. In addition, three families namely *Acanthaceae, Cyperaceae* and *Rosaceae* emerge as dominant families in India. *Acanthaceae* are one of the dominant families of our forests in Southern India as well as in the then British India (Gamble, 1967). India offers an excellent habitat for members of *Cyperaceae.* Himalayan region is rich in *Rosaceae.*

Table 2: TOTAL NUMBER OF TAXA IN INDIA

CATEGORY	NUMBER
Species	16,809
Subspecies	282
Varieties	2,203
Subvarieties	33
Forma	68
Total	19,395

Source: Karthikeyan, 2000

Table 3: TEN MOST SPECIOSE FAMILIES OF INDIA

S.NO.	FAMILY	NO. OF SPECIES
1	*Poaceae*	1,291
2	*Orchidaceae*	1,229
3	*Leguminosae*	1,192
4	*Asteraceae*	800
5	*Rubiaceae*	616
6	*Cyperaceae*	545
7	*Euphorbiaceae*	527
8	*Acanthaceae*	500
9	*Lamiaceae*	435
10	*Rosaceae*	432

Source: Karthikeyan, 2000

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Tamil Nadu is the most speciose state with about 5,200 species among the different states of India (Annamalai, 2004; www.envis.tn.nic.in). This richness in species diversity of Tamil Nadu can be attributed to the rich diversity of habitats from hot and humid coastal plains to high altitude montane regions as well as to the intensive explorations for the past 200 years. It is interesting to note that the states with rich forest regions such as Arunachal Pradesh, Karnataka, Kerala, Sikkim and Uttaranchal have comparatively less diversity of angiosperms. This is primarily due to the less diverse range of habitats in these states when compared to Tamil Nadu (Fig.1).

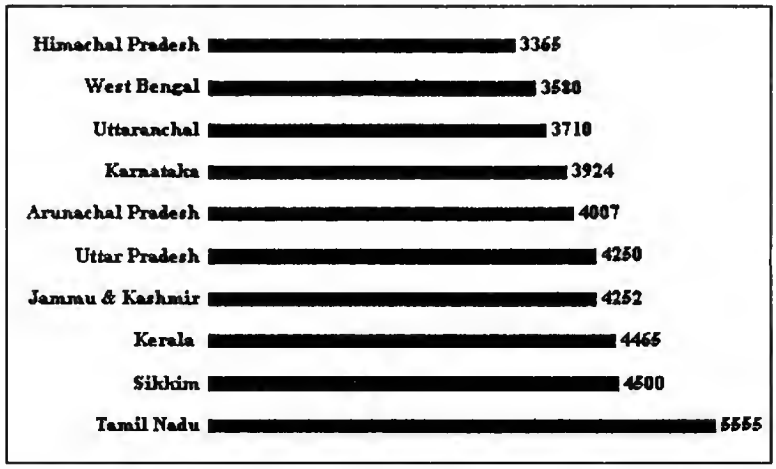

Fig. 1: TEN MOST SPECIOSE STATES OF INDIA

Source: Annamalai, 2004; Sasidharan, 2004; Sharma *et al.*, 1984; www.envis.tn.nic.in

The state of Tamil Nadu harbours a total of 5,555 taxa that include 5,200 species and their sub-specific categories (Table 4). Herbaceous plants constitute 55% of these taxa whereas, the trees form only 17% of the total taxa (Table 5). About 40% of the plants endemic to Tamil Nadu are also herbs. This emphasizes the need for reorientation of our conservation programmes. Most of our conservation programmes are aimed at arborescent taxa. Similarly, the habitat destruction/conversion silently affects the herbaceous flora whereas, damage done to trees are more visible and hence, come to the notice of public.

Table 4: TOTAL NUMBER OF TAXA IN TAMIL NADU

CATEGORY	NUMBER
Species	5200
Subspecies	39
Varieties	314
Subvarieties	-
Forma	2
Total	5555

Source: www.envis.tn.nic.in

Table 5: LIFE FORMS OF ANGIOSPERMS IN TAMIL NADU

LIFE FORM	NUMBER OF TAXA
Herbs	3,033
Shrubs	1,496
Trees	959
Stragglers/Lianes	67
Total	**5,555**

Source: www.envis.tn.nic.in

Several families that dominate the angiosperm flora of the world and India also dominate the angiosperm flora of Tamil Nadu (Table 6). The family Myrtaceae emerge as a locally dominant family that are primarily distributed in Western Ghats. Western Ghats of Tamil Nadu is the most biodiversity rich region of the state that harbours about 45% of the wild plants of the state. Another 18% of the taxa are common to Eastern and Western Ghats. About 15% of the plants are distributed throughout the state especially in the plains and lower elevations.

Table 6: TEN MOST SPECIOSE FAMILIES OF TAMIL NADU

S.NO.	FAMILIES	GENERA	SPECIES
1	*Leguminosae*	118	510
2	*Poaceae*	144	451
3	*Asteraceae*	102	264
4	*Rubiaceae*	57	212
5	*Orchidaceae*	67	196
6	*Euphorbiaceae*	52	194
7	*Cyperaceae*	16	188
8	*Acanthaceae*	46	182
9	*Lamiaceae*	31	143
10	*Myrtaceae*	16	106

Source: www.envis.tn.nic.in

Endemic Angiosperm Diversity

Biologists today recognize 34 biodiversity hotspots based on the richness of endemic species. Regions that consist of 1500 or more endemic species are classified as hotspots (Myers *et al.*, 2000). Three of the currently recognized biodiversity hotspots occur in India. They include Indo-Burma, Western Ghats and Sri Lanka and Himalayas (Synge, 2005). Ten of the world's biodiversity hotspots are Island regions; they include Caribbean Islands, East Melanesian Islands, Japan, Madagascar & Indian Ocean Islands, New Caledonia, New Zealand, Philippines, Polynesia-Micronesia, Sundaland and Wallacea (Table 7).

Table 7: BIODIVERSITY HOTSPOTS OF THE WORLD (REGIONS RICH IN ENDEMIC SPECIES)

S.No.	Name of the Hotspot Region	Total Species	Endemic Species
1	Atlantic Forest	20,000	8,000
2	California Floristic Province	3,488	2,124
3	Cape Floristic Region	9,000	6,210
4	Caribbean Islands	13,000	6,550
5	Caucasus	6,400	1,600
6	Cerrado	10,000	4,400
7	Chilean Winter Rainfall – Valdivian Forests	3,892	1,957
8	Coastal Forests of Eastern Africa	4,000	1,750
9	East Melanesian Islands	8,000	3,000
10	Eastern Afromontane	7,598	2,356
11	Guinean Forests of West Africa	9,000	1,800
12	Himalaya	10,000	3,160
13	Horn of Africa	5,000	2,750
14	Indo-Burma	13,500	7,000
15	Irano-Anatolian	6,000	2,500
16	Japan	5,600	1,950
17	Madagascar & the Indian Ocean Islands	13,000	11,600
18	Madrean Pine-Oak Woodlands	5,300	3,975
19	Maputaland-Pondoland-Albany	8,100	1,900
20	Mediterranean Basin	22,500	11,700
21	Mesoamerica	17,000	2,941
22	Mountains of Central Asia	5,500	1,500

23	Mountains of Southwest China	12,000	3,500
24	New Caledonia	3,270	2,432
25	New Zealand	2,300	1,865
26	Philippines	9,253	6,091
27	Polynesia-Micronesia	5,330	3,074
28	Southwest Australia	5,571	2,948
29	Succulent Karoo	6,356	2,439
30	Sundaland	25,000	15,000
31	Tropical Andes	30,000	15,000
32	Tumbes-Choco-Magdalena	11,000	2,750
33	Wallacea	10,000	1,500
34	Western Ghats & Sri Lanka	5,916	3,049

Source: Synge, 2005; www.conservation.org

One-third of the total numbers of taxa in India are endemic to the political boundaries of India. Though, India is rich in endemic species, it is poor in generic endemism. Our analysis shows only 113 genera are strictly endemic to India that constitutes a meagre 4% of the total genera. However, no plant family is endemic to India. Families such as *Lauraceae, Apiaceae, Ranunculaceae, Rosaceae* and *Balsaminaceae* (Table 8) show high degree of endemism in India. Several of these families such as *Apiaceae, Balsaminaceae, Liliaceae, Primulaceae and Ranunculaceae* are herbaceous families, a fact that once again emphasizes the reorientation of conservation programmes by focusing on habitats rather than on species. The state of Tamil Nadu has 270 strict endemics that occur only within the state boundaries, majority of which are herbs and are distributed in Southern Western Ghats (www.envis.tn.nic.in).

Table 8: FAMILIES SHOWING HIGH ENDEMISM

FAMILY	TOTAL NO. OF TAXA	TOTAL ENDEMIC TAXA	% OF ENDEMICS
Lauraceae	163	133	80.9
Apiaceae	209	165	78.8
Ranunculaceae	180	135	75.0
Rosaceae	250	182	72.8
Balsaminaceae	180	123	68.3
Acanthaceae	380	224	58.9
Liliaceae	203	114	55.6
Primulaceae	165	80	48.4
Ericaceae	168	80	47.6
Rubiaceae	500	205	41.0

Source: Nayar, 1996

Threatened Plant Diversity

About 8000 species of flowering plants are estimated to be threatened globally (Groom *et al.*, 2006; www.iucnredlist.org). About 1500 species of Angiosperms in India are considered to be under various threat categories (Pal, 1987). However, there is an urgent need to update the list of threatened plants in India and to evaluate them as per current IUCN norms. Nearly one-tenth of the plant diversity of Tamil Nadu is under threat. Our analysis shows that about 522 taxa are threatened in Tamil Nadu of which majority are (80%) distributed in Western Ghats. A critical perusal of IUCN database on Red-listed plants brings forth seven globally extinct species from the state of Tamil Nadu (Table 9). However, their status needs to be assessed further based on intensive field explorations.

Table 9: GLOBALLY EXTINCT SPECIES FROM TAMIL NADU

SPECIES	LOCALITY
Claoxylon wightii Hook.f. var. *angustatum* Susila & Balakrishnan	Tirunelveli
Derris brevipes Baker var. *travencorensis* Thoth.	Kanyakumari
Dalbergia travancorica Thoth.	Kanyakumari
Lasianthus obovatus Bedd.	Tirunelveli
Marsdenia tirunelvelica A.N. Henry & Subram.	Tirunelveli
Symplocos macrophylla Wall ex. DC. subsp. *rosea* (Bedd.) Nooteb.	Tirunelveli
Syzygium beddomei (Duthie) Chithra	Tirunelveli

Source: Gopalan & Henry, 2000; www.iucn.org

Centre for Floristic Research (CFR), Department of Botany, Madras Christian College, has brought to light one such species namely, ***Syzygium gambleanum*** Rathakr. & Chithra. This species was considered extinct by the IUCN as well as by Gopalan & Henry (2000). A team of researchers from CFR has relocated this species from its type locality and has reassessed its status as critically endangered. Similarly, a number of other species thought to be extinct from Western Ghats of Southern India have been relocated. They include ***Dalbergia tinnevelliensis*** Thoth. (Viswanathan *et al.*, 2004), ***Syzygium bourdillonii*** (Gamble) Rathakr. & N.C. Nair (Mohanan, 1996), ***S. myhendrae*** (Bedd. ex Brandis) Gamble (Sasidharan *et al.*, 2002) and ***S. palghatense*** Gamble (Sujanapal & Sasidharan, 2002). These rediscoveries clearly show that intense, target-oriented field explorations are necessary to say a final word on those supposed

to be extinct taxa. The need for exploration can also be explained in terms of new taxa described within the last one and a half decades. As many as 47 taxa have been newly described from the Southern Western Ghats of Tamil Nadu. Several areas of Tamil Nadu such as Western Ghats of Kanyakumari and Tirunelveli districts, offshoots of Western Ghats such as Meghamalai and Azhagar hills, Hill ranges of Eastern Ghats such as Kolli, Javadhi and Kalrayan as well as specialized habitats such as hill streams and rivers are still under-explored (Narasimhan, Chandrakala & Rathnakumari, 2005; www.envis.tn.nic.in). The mammoth task of documentation of plant diversity in Tamil Nadu can only be carried out with the help of trained taxonomists. There is a paucity of trained taxonomists in India in general and especially in Tamil Nadu.

Colleges can play an important role in documentation of biodiversity. Each college can intensively explore its neighbourhood and maintain a record of biodiversity of the region. Such locale specific biodiversity informations can be pooled together to consolidate the data on species diversity, distribution patterns and rarity of species.

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FLORAL WEALTH OF THE GOVERNMENT MUSEUM, CHENNAI

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ABSTRACT

Government Museum, Chennai is located in the heart of the city, in a vast area covering 16 acres of land,full of greenery and floral diversity. The greenery of the shrubs and trees and the landscape present a happy scenario along with the imposing heritage structures to the visiting public.

Organic evolution of the biosphere perpetually contributed to the growth of many flora resulting in the speciation of higher forms especially the angiospermic trees and herbs of economically and medicinally important species. The plants and trees that are introduced in the Government Museum, Chennai formed a treasure house of flora of more than 100 year old plants in existence. These are maintained well with the bilingual label on the trees, facilitating the easy identity of the trees and plants for the visitors.

It is noteworthy to say about a pond in the backside of the museum (facing Halls road) where in more than a dozen species of flowering plants can be identified. During the rainy season when the pond is filled with rainwater, few of the migratory birds could also be seen.

In the modern era naturalists and general public are concerned about the depletion of valuable species that form a Biodiversified habitat in different eco systems.

Chennai Museum is spectacular not only in the display and conservation of historical artifacts, but also in exhibiting the floral and faunal collection and preservation of diversified specimens. The floral representation of very many species of flowering plants drawn from different geograhical locations of the country is a pride of the Chennai Museum indeed.

A brief account of taxonomically interesting and economically important plants,numbering about sixty nine ,seen in the Museum campus is presented along with illustrative colour photographs for useful guidance.

The flora includes both Angiosperms and a few Gymnosperms. The list of plants are alphabatically arranged for easy identification with botanical nomenclature and also with local and vernacular names.

Acacia auriculiformis A.Cunn.
MIMOSACEAE

Leaves mostly bipinnate. They possess simple leaves which are actually phyllodes or like petioles having no blade. Stipules often modified in to thorns. Androecium numerous and free. Grows as trees up to 12m tall. Flowers yellow. Tree is native of Australia. Cultivated in gardens and avenues for shade. Flowers November-March. Fruit January-June. It is a useful sand binder. The bark contains tannin and as wattle bark.

Adansonia digitata Linn.
BOMBACACEAE
Tamil : Aanaipuli; English : Baobab tree/ Monkey Bread tree; Hindi : Gorakamli

The tree is native of Africa. Deciduous trees with massive trunk which grows up to 15m tall. Leaves digitately compound. Leaflets oblancate to elliptic. Flowers pendulous and blooms during December to February. Fruits during the months of February to August. They are woody and indehiscent. The trunk of the tree sometimes becomes hollow and forms a water reservoir. Fruit pulp gives relief in bronchial asthma. The wood yields paper pulp for writing paper.

Adenanthera pavonina Linn.
MIMOSACEAE
Tamil : Aanai gundumani; English : The Coralwood; Telugu : Bandiguruvenda;
Sanskrit : Kunchandana

Trees grows up to 10m tall. Flowers pale white. Seeds used as jeweler's weight. Occasionally cultivated in parks and avenues. Commonly called as 'redwood'. The red heartwood is used as a substitute for true red sandalwood (*Pterocarpus santalinus*).

Albizzia lebbeck Benth.
MIMOSACEAE
Tamil : Vagai; English : Siris tree/The East Indian Walnut

Tree is a native of tropical Himalaya. Grows in India, Southeast Asia, and Srilanka up to 15m high. Flowers December-May. Fruit throughout the year. The tree yields a gum which is used as an adulterant of gum arabic. Pods are straight. Timber used in building and for furniture.

Allamanda cathartica Linn.
APOCYNACEAE
Telugu : Allamanda thega; English : The Golden Trumpet; Kannada : Allamandagide

Straggling or climbing shrubs. Flowers yellow; corolla funnel shaped. Commonly cultivated in gardens as ornamental shrub. Flowers throughout the year. The roots contain an antileukemia lactone, called as 'allamandin'.

Acacia auriculiformis

Adansonia digitata

Adenanthera pavonina

Albizzia lebbeck

Allamanda cathartica

Anogeissus acuminata

Araucaria heterophylla

Azadirachta indica

Borassus flabellifer

Caesalpinia coriaria

Carica papaya

Anogeissus acuminata Wall. ex Bedd.
COMBRETACEAE
Tamil : Nunnera; Telugu : Lanchman

Trees which grows up to16m tall. Leaves are elliptic in shape. Flowers greenish. Flowers and fruits February-April. Cultivated in gardens and avenues. Wood strong and used for tool handles.

Araucaria heterophylla (Salisb.) Franco.
ARAUCARIACEAE
English : Norfolk Island Pine

Grows as trees, up to 10m tall. Branches are whorled. Leaves rigid, dense persistent. Commonly cultivated in gardens as ornamental tree. It is introduced and native to Australia. Wood used for furniture.

Azadirachta indica A.Juss.
MELIACEAE
Tamil : Veppa maram; English : The Neem tree; Sanskrit : Nimba; Hindi : Nim

Trees that grows up to 12m tall. Leaflets are lanceate to ovate. Flowers white in color. Commonly cultivated around houses. Flowers March-May. Fruits April- July. The bark is used for skin troubles. The tree is a native of India. This is used in indigenous medicine.

Borassus flabellifer Linn.
ARECACEAE
Tamil : Panai; English : Palmyra Palm; Sanskrit : Tal; Hindi : Tar

Dioecious tree that grows up to 18m tall. The trunk measures more than 25 cm across. The juice obtained from the inflorescence is a sweet drink. The endosperm of the tender fruits is called as 'nongu' in Tamil and it is edible. The older leaves are used for thatching the roof.

Caesalpinia coriaria (Jacq.) Willd.
CAESALPINIACEAE
Tamil : Konapuli / Inkimaram; English : The Divi divi

Shrubs or trees that grow up to 6m tall. Leaflets linear to oblong. The tree is a native of South America. Found in Central and W.Indies. Pods and fruit yield tannin. Leaves are compound. Decoction of pods used to stop bleeding in piles. Commonly cultivated in garden.

Carica papaya Linn.
CARICACEAE
Tamil : Pappali; English : Papaya; Telugu : Boppaayi; Hindi : Apeta

Dioecious trees with soft stems, up to 8m tall. Leaves palmately parted. Flowers cream colored, staminate in axillary panicles, the pistillate in axillary fascicles or solitary. Commonly

cultivated around houses. Unripe fruits used as vegetable. Ripe ones are eaten and also employed in the preparation of candies and soft drinks. It is a source of Vitamins.

Caryota urens Linn.
ARECACEAE
Tamil : Tippili, Koondalpanai; English : Kittul, Sago,Toddy or fishtail palm

Monoecious trees that grows up to 12m tall. Leaflets broadly cuneate. Cultivated in parks as an ornamental. Spadices long, axillary, pendulous. Yields a fibre called kittul fibre. Used in the manufacture of brushes and brooms. It is a source of sweet toddy and sago.

Cascabella thevetia Linn.
APOCYNACEAE
Tamil : Manchal alari

Shrubs or small trees, that grows up to 7m tall. Commonly cultivated in gardens as a hedge plant. Flowers and fruits throughout the year. Flowers yellow, pink, or white in terminal cymes. Corolla funnel form.

Cassia siamea Lam.
CAESALPINIACEAE
Tamil : Manchakonnai; Telugu & Kannada : Simatangedu

Grows as trees. Commonly cultivated in gardens and avenues. Wood black in color and used for furniture. Flowers and fruits throughout the year. Pods long flattened. Leaves used as manure.

Casurina equisetifolia Linn.
CASUARINACEAE
Tamil : Savukku; English : The Beefwood; Telugu : Sarugudu; Hindi : Jangli saru

It grows as tree up to 20m tall. Cladodes joined at nodes. Flowers minute in size. Commonly cultivated in plantations along sandy seashores and near lakes, also in parks, as ornamental and hedge plant. Extensively cultivated for fuel. Bark used for dyeing and tanning.

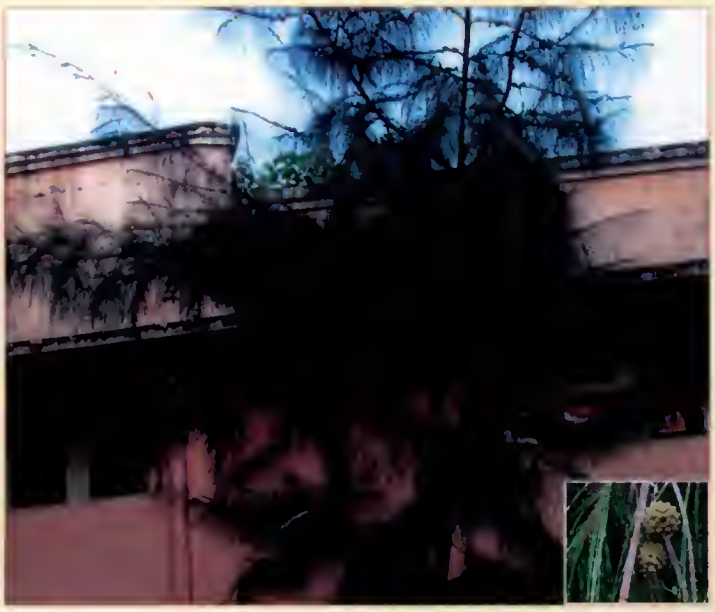
Ceiba pentandra (Linn). Gaertn.
BOMBACACEAE
Tamil : Ilavum, Elavam, panjumaram; English : White Silk Cotton tree, True Kapok tree
Telugu : Tella buraga; Sanskrit: Sveta salmal

Deciduous trees, up to 15m tall. Leaves digitately foliolate. Flowers white. Fruits with cottony fibres within. Cultivated around houses. Fibres used for stuffing pillows, mattresses etc. Seeds yield fatty oil called as the 'kapok seed oil'. Pressed cake used as feed for cattle.

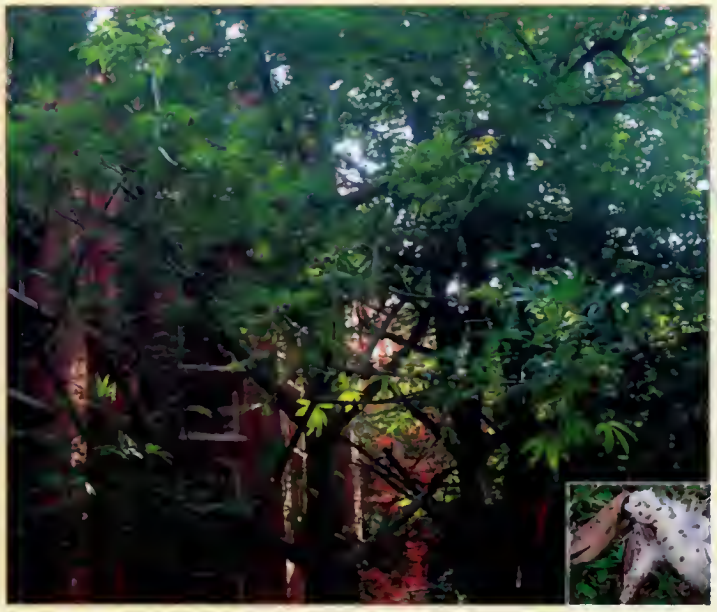
Caryota urens

Cascabella thevetia

Cassia siamea



Casurina equisetifolia



Ceiba pentandra

Cocos nucifera

Cordia obliqua

Couropita guianensis

Crinum asiaticum

Cycas circinalis

Cocos nucifera Linn.
ARECACEAE
Tamil : Tennaimaram; English : Coconut; Sanskrit : Narikela; Telugu : Tenkaya

It is a monoecious tree which grows up to 18m tall. Leaves 3-6m long. Endosperm is edible. It is a tree of much commercial value. Coconut oil employed in food products and in soaps, is used in culinary preparation, cosmetics. Coconut fibre used for mats, ropes, baskets, brushes etc. Leaves woven in to mats. Midribs of leaflets made in to brooms. Coconut water of tender fruit is a sweet drink.

Cordia obliqua Willd.
CORDIACEAE
Tamil : Naruvili, Mokkuchali; Kannada : Chikkachalle; Telugu : Chinna nakkeru;
Hindi : Lasora

Trees which grows up to 10 m tall. Leaves ovate to sub orbicular or elliptic. Flowers pale white. Planted along roadsides and railway tracks. Flowers March-May. Corolla white in color. The wood is durable in contact with water and used for boats.

Couropita guianensis Aubl.
LECYTHIDACEAE
Tamil : Nagalingam; English : The Cannon ball tree

The tree is a native of tropical America. They grow up to 12m tall. Leaves are oblong. Flowers are red in color in long pendulous panicle. Fruits globose, with woody pericarp. Commonly cultivated in gardens, as an ornamental tree. Flowers and fruit throughout the year. Berries with woody pericarp. Fruit shells used as utensils. The name of the tree is derived from the shape of the flower which is like the hood of the snake.

Crinum asiaticum Linn.
AMARYLLIDACEAE
Tamil : Vishamungil; Telugu : Kesarchettu; Sanskrit : Naadamani

It is a common ornamental plant. Herbs with underground bulbs. Monocotyledons, epigynae, leaves lanceate margin entire. Flowers white. Cultivated in gardens and also runs wild. Leaves and roots diaphoretic.

Cycas circinalis Linn.
CYCADACEAE
Tamil : Canningay, madanagama; Sanskrit : Varaguna; Telugu: Kamkshi;
Hindi : Jangli madan, mast-ka-phul

'Sago', is extracted from the trunk of about 7 year's old plant before fruiting. Small tree

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which grows up to 3 m tall. Leaves long. Leaflets linear, microsporophyll in compact cones. Megasporophylls loosely arranged. It grows on rocky slopes and also cultivated.

Cynodon dactylon Pers.
POACEAE
Tamil : Arugampul; English : Dhub grass, Bermuda, Bahama grass; Telugu : Gerich; Hindi : Hariali

Perennial herbs; leaf blades linear to oblong. Spikes solitary. A weed of moist and dry places, also cultivated in lawns. It is a good soil-binder. It is valued as a pasture and lawn grass.

Dalbergia latifolia Roxb.
FABACEAE
Tamil : Itti, Karundorviral; English : The East Indian Rosewood, Bombay Blackwood, Indian Rosewood; Sanskrit : Shishapa; Hindi : Shisham

Tree commonly cultivated in parks and avenues. Lateral leaflets are alternate. It yields the finest wood which is valuable and used for carving, ornamental plywood, suitable for pattern making, calico-printing block, mathematical instruments and screws.

Delonix regia Rafin.
CAESALPINIACEAE
Tamil : Mayarum, Neruppu konrai ; English : The Flamboyant flame tree, Gul mohr, Gold mohr

Grows as trees, up to 12m tall. Leaflets oblong. Flowers in terminal and axillary corymbs. Sepals valvate. Commonly cultivated in gardens and avenues as an ornamental tree; also grown as shade tree. Seeds contain gum which is eaten by squirrel.

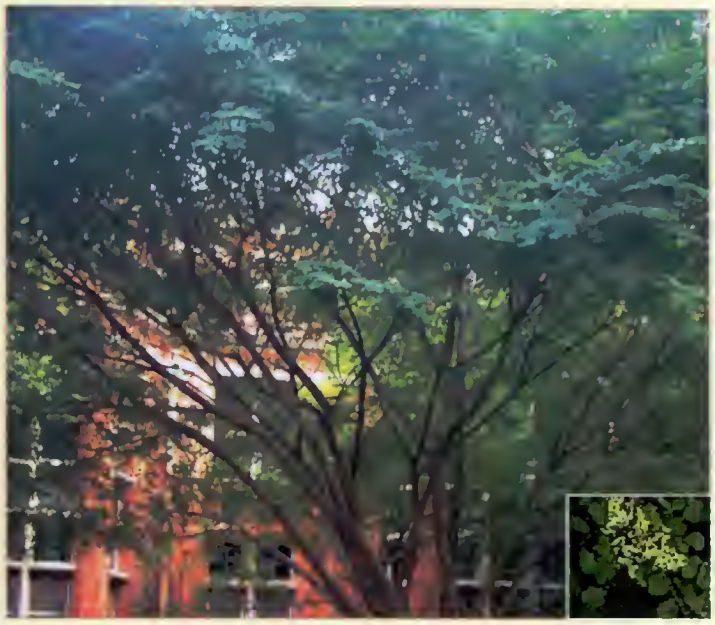
Desmodium gangeticum DC.
PAPILIONACEAE
Tamil : Pulladi, orilai; Telugu : Gitanaram; Sanskrit : Shalaparni; Hindi: Sarivan

Grows as under shrubs, up to 1m tall. Leaves ovate-elliptic. Flowers purplish. A weed of waysides and waste places. Fairly common. Flowers and fruit October to March. Decoction of leaves consumed for arthritis. Roots used as febrifuge. Suitable for paper making.

Dracaena angustifolia Roxb.
LILIACEAE
Hindi : Buckripathi

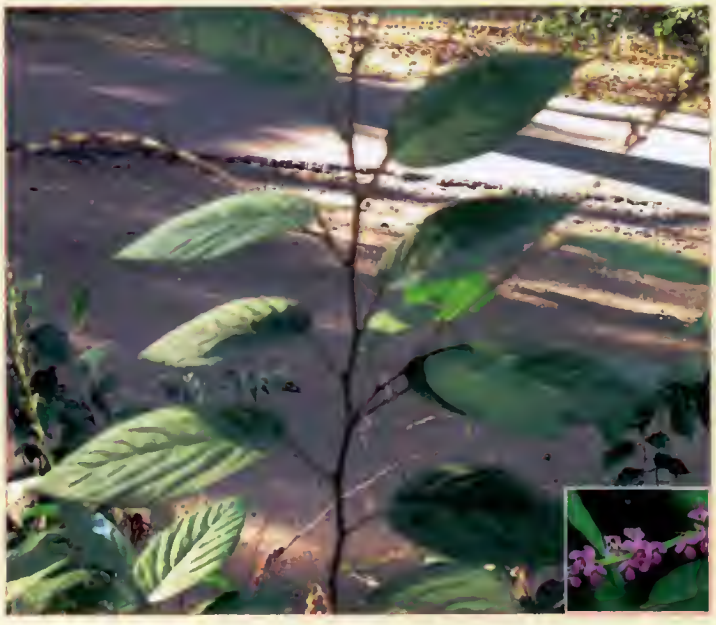
Grows as shrub and also as a tree. Used as fodder for goat.

Cynodon dactylon



Dalbergia latifolia

Delonix regia



Desmodium gangeticum

Dracaena angustifolia

Eucalyptus umbellata

Ficus benghalensis

Ficus religiosa

Ficus glomerata

Guaiacum officinale

Eucalyptus umbellata Domin.
MYRTACEAE
Tamil : Thylamaram

It is a native of Australia. Trees grow up to 18 m tall. Leaves falcate, lanceate or ovate. Commonly cultivated in forest, garden and park. The wood is used in paper industry. Flowers during November to March. Fruits during January to April.

Ficus benghalensis Linn.
MORACEAE
Tamil : Alamaram; English : The Banyan tree; Sanskrit : Bahupada, Vata; Hindi: Bar, Bargad

Trees with numerous aerial roots, grows up to 20m tall. Leaves ovate. Flowers in hypanthodia. Birds eat fruits. Large trees accommodate several other species of plants. Flowers and fruit during January to August. Wood suitable for making paper-pulp.

Ficus glomerata Roxb.
MORACEAE
Tamil : Atthi; English: Atti,Bodda; Sanskrit : Udumbara; Hindi : Gular, Umar

Plants cauliflorous. Trees grow up to 15m tall. Leaves are elliptic oblong, pubescent. Syconia red when ripe. Often seen around dwellings. Flowers and fruits throughout the year. Yields vegetable oil.

Ficus religiosa Linn.
MORACEAE
Tamil : Arasamaram; English : The Peepal tree; Hindi : Pipal, pipli Sanskrit : Ashvatha pipala

Trees grow up to 20 m tall, without aerial roots. Leaves glaucous beneath. Syconia purplish to pink when ripe. Found along roadsides and other places, often near Hindu temples. Flowers and fruit during February to July. Fruits and tender buds eaten in times of scarcity. Hardened latex used to fill up cavities in hollow ornaments.

Guaiacum officinale Linn.
ZYGOPHYLLACEAE
English : Lignum vitae

Leaves are pinnate. Leaflets in two pairs, obovate to elliptic. Fruit a yellow capsule. Occasionally cultivated in garden and park as an ornamental. Flowers during November to March. Fruits during December to April. Wood used in the manufacture of segment bearings in steamship propeller shaft assemblies. It is also used for pulley sheaves, stencil and chisel blocks. The tree is commonly called as 'Life tree', which yields valuable timber.

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Guazuma ulmifolia Lam.
STERCULIACEAE
Tamil : Thenmaram; Telugu : Thene chettu; Malayalam : Rudraksham; Oriya: Debodaru

Tree is native of tropical America and Java. Trees grow up to 12m tall. Leaves 6-12, ovate to lanceate, base is oblique. Flowers 6mm across. Fruits woody. Occasionally cultivated as avenue tree. Sometimes runs wild. Flowers and fruits throughout the year. Stem yield a fibre used for ropes.

Kigelia pinnata DC.
BIGNONIACEAE
English : Common Sausage tree

The tree is a native of Africa. It grows up to 18 m tall. Leaflets 2-4 pairs, ovate to oblong. Flowers purplish brown or yellowish brown. Fruits woody. Commonly cultivated along roadsides and parks. Flowers December to May. Fruits throughout the year. The tree is pollinated by bats. Roasted seeds eaten in times of scarcity.

Lannea coromandalica (Houtt). Merr
ANACARDIACEAE
Tamil : Wodier, Kalasan, Udhyamaram; Telugu : Appriyata; Malayalam : Odiya maram; Kannadam : Ajasringi

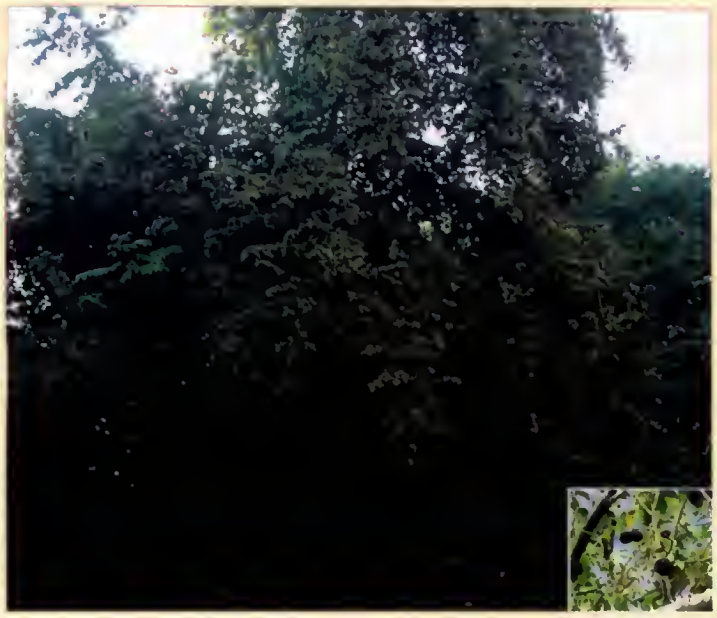
It is a deciduous tree which grows up to 15 m tall. Leaves unipinnate leaflets 5-11 elliptic or ovate. Flowers yellow in axillary, pendulous, spicate panicles. Fruits pale red when ripe. Flowers April to June. Fruit May to August. Wood used locally for house building, packing cases, furniture, and wheel spokes.

Lantana camara Linn.
VERBENACEAE
Tamil : Unnichedi; Telugu : Pulikampa; Kannadam : Nada hugida; Malayalam : Arippu

Prickly shrubs, often straggling leaves; ovate, serrate, scabrous leaves. Flowers pinkish to orange, red or yellowish in axillary peduncle heads. Flowers and fruits throughout the year. Fruits eaten by children. Occasionally used as green manure. Flowers also yield an essential oil similar to that of the leaf oil.

Limonia acidissima auct. non Linn.
RUTACEAE
Tamil : Vilvamaram; English : The Wood Apple tree

Trees that grow up to 12m tall. Leaves 5-7 foliolate; rachis winged. Flowers in axillary or terminal corymbs. Berries up to 6 cm across. Occasionally cultivated around houses. Flowers March to June. Fruits throughout the year. Fruits edible when ripe.



Guazuma ulmifolia

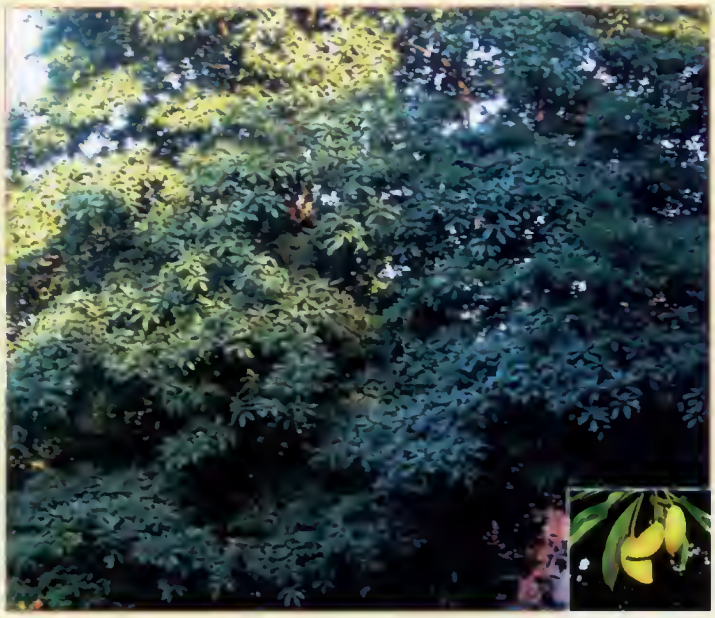
Kigelia pinnata

Lannea coromandalica

Lantana camara

Limonia acidissima

Livistona chinensis



Madhuca longifolia

Mangifera indica

Manilkara zapota

Melia azadarach

Livistona chinensis R. Br.
ARECACEAE
English : Chinese fan palm

Occasionally cultivated in gardens as an ornamental tree. They grow up to 8m tall. Flowers and fruit throughout the year. Leaves used for making fan. Fibre of the leaf-stalk made in to ropes.

Madhuca longifolia (Koenig) Macbr.
SAPOTACEAE
Tamil : Illupai; English: South Indian Mahua, Mowra Butter tree

Deciduous trees up to 10 m tall. Leaves lanceate to oblong. Flowers pale yellow. Commonly cultivated along roadsides and parks; it also runs wild. Flowers March to May. Fruit June to September. Mahua flowers are rich in sugar, used in the preparation of distilled liqueurs and vinegar. Also used for making syrup.

Mangifera indica Linn.
ANACARDIACEAE
Tamil : Manga; English : The Mango; Kannada : Mavu; Malayalam : Mava

Indigenous tree found in India, Burma, Thailand and Indo-China. Fruits during March to May. Wood used for beams, rafters, trusses door and window shutters and also for inferior furniture. The fruits are edible.

Manilkara zapota Linn.
SAPOTACEAE
Tamil : Sappotta; Telugu : Manjipala; Kannada : Bakula; Malayalam : Pala

Grows as shrub or tree. Tree grows up to 8m tall. Leaves narrowly elliptic, coriaceous. Flowers axillary, solitary. Berries brown. Flowers during February to July. Fruits during March to September. Tree is a native of South America which is cultivated for the fruits. Yields strong and dense timber and are used for sugar mills and oil presses, piles, posts, beams, carts and agricultural implements. Leaves used as cattle fodder.

Melia azadarach Linn.
MELIACEAE
Tamil : Malai Vembu; English: The Persian Lilac; Telugu : Turaka vepa

Tree which grows up to 8m tall. Leaflets ovate, obovate or lanceate. Flowers violet in axillary panicles. Occasionally cultivated around houses. Flowers October to February. Fruit through out the year. Wood used for making toys, cigar, and ammunition boxes and for packing cases.

Leaves, bark and fruits have insect repellent properties; juice of the leaf is used as antihelmintic& diuretic and fruits as tonic.

Mimusops elengi Linn.
SAPOTACEAE
Tamil : Vagulam,magadham; Telugu : Pogada; Malayalam : Elanji; Sanskrit : Bakula

Trees that grow up to 10 m tall. Leaves, oblong elliptic, glabrous. Occasionally cultivated in gardens and avenues. Flowers during March to May. Fruit during June-September. Corollas used by women to adorn their hair. Wood used for building purposes, piles, bridges, boats. Fruits are edible and made in to pickles.

Millingtonia hortensis Linn. f.
BIGNONIACEAE
Tamil : Maramalli; English : Indian cork tree

Tree grows up to 15m tall. Leaflets many. Flowers white, sweet scented in panicles. Native of Malaysia. Found in South East Asia also. Cultivated in garden and park as ornamental tree. Flowers from December to March. Fruit February to May.

Morinda citrifolia Linn.
RUBIACEAE
Tamil : Nuna; Sanskrit : Ashyuka; Hindi : Al; Telugu : Togaru

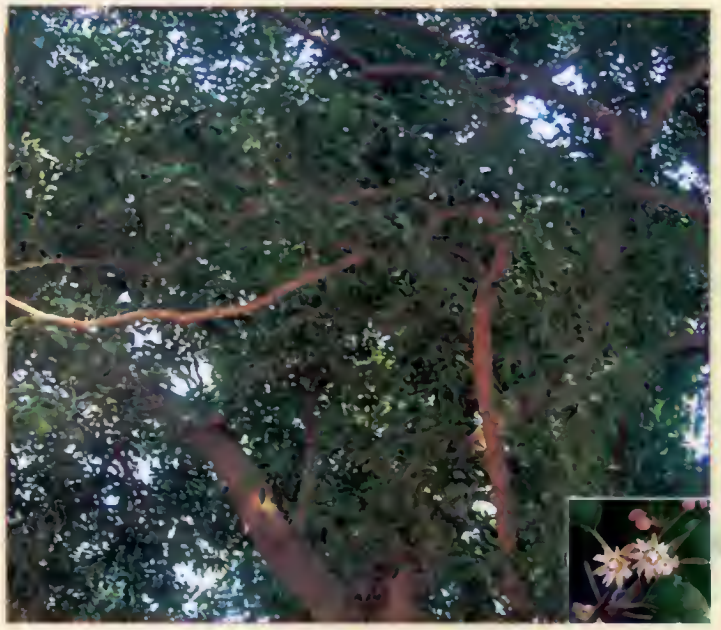
Tree that grows up to 8m tall. Leaves elliptic or lanceate. Flowers, white, sessile in heads. Fruits black when ripe. Grows in scrub jungles, thickets and waste places. Flowers May to September. Fruits are found through out the year.

Peltophorum pterocarpum Backer
CAESALPINIACEAE
Tamil : Perungondrai; Telugu : Kondachinta; English : Copper pod tree

Trees grow up to 12 m tall. Young parts rusty and tomentose. Pinnae 13 pairs, leaflets oblong. Flowers 3 cm across, yellow. Commonly cultivated in parks and avenues. Flowers during February to August. Fruit throughout the year. Bark used for tannin. Wood and leaves contain tannin. Leaves rich in protein. Used as cattle feed.

Phoenix sylvestris Roxb.
ARECACEAE
English : The Wild Date palm; Tamil : Icham; Kannada : Ichalu; Hindi: Khajur

Tree that grows up to 10 m tall. Leaves with long spines near the base. Grows in waste places near roadsides, rice fields etc. Flowers during October-January. Fruits during November to April. Leaflets split and woven in to mats, brooms, baskets etc. Toddy is obtained from the inflorescence. Sap of the tree is used for making jaggery and the sugar sap called 'Nira' which is a good source of vitamin B & C.



Mimusops elengi

Millingtonia hortensis

Morinda citrifolia

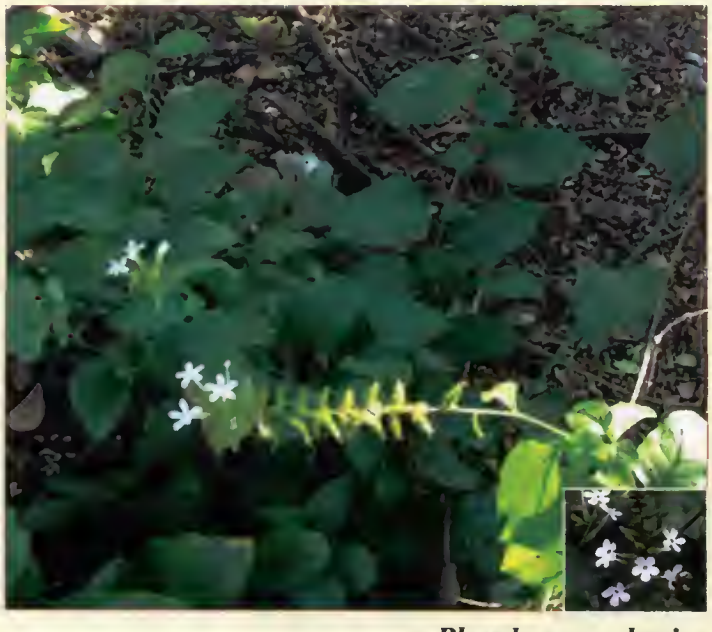
Phoenix sylvestris

Peltophorum pterocarpum

Phyllanthus emblica

Pisonia grandis

Pithecellobium dulce



Plumbago zeylanica

Polyalthia longifolia

Phyllanthus emblica Linn.
EUPHORBIACEAE
Sanskrit : Adiphala, amalaka; Hindi : Amla English : Emblic myrobalan, Indian gooseberry; Telugu : Amalakamu, usirikai; Tamil : Nelli

Grows as tree. The branchlets up to 30 cm long, pulvinate at the base. Leaves 6-18 linear oblong, glabrous. Flowers pale white, axillary. Flowers and fruits July- September. Fruits edible, made in to pickles. It is a rich source of Vitamins. Fruits used in hair dye. The wood is used for agricultural implements.

Pisonia grandis R. Br.
NYCTAGINACEAE
Tamil : Lechai, kottai; English : The Lettuce tree; Telugu : Lanchamundaku; Kannada : Sulesoppu

Leaves consumed as a vegetable and salad. Also used to feed the cattle. The fresh leaves moistened with Eau-de-cologne; used to bring down inflammation of filarioid nature.

Pithecolobium dulce Benth.
MIMOSACEAE
Tamil : Kodukkaapuli; English : The Manila tamarind; Kannada : Kottampuli

The tree is a native of Mexico. Tree grows up to 12 m tall with stipular spine. Leaflets oblong to elliptic. Flowers white in globose heads. Seeds enveloped by spongy, whitish or pinkish aril. Grows in jungles thickets and also along roadsides. Fairly common. Flowers during December to April. Fruits February to August. The aril is edible. Pods are curved. Leaves and pods serve as fodder. Wood used for general construction. Seeds eaten raw or in curries.

Plumbago zeylanica Linn.
PLUMBAGINACEAE
Tamil : Chithiramulam; Sanskrit : Chitraka; Malayalam : Tumba koduveli; Gujarati : Chitrak

Rambling under shrubs. Leaves ovate or ovate-lanceate. Flowers in terminal spikes. The capsules split at the apex. Root is abortifacient, vesicant and diuretic. Used in dyspepsia, piles, diarrhea and skin diseases. The root, the bark contains 'Plumbagin', which is the active principle.

Polyalthia longifolia Thw.
ANNONACEAE
Tamil : Nettilingam; English : The Mast or Cemetery tree; Hindi : Asoka; Gujarathi : Asopalav

Tree which grow up to 12 m tall. Leaves undulate, base obtuse, apex acuminate. Flowers greenish, fruits subcylindric turning to brown and then purplish. Commonly cultivated as an ornamental tree. Flowers February to April. Fruits April to September. The wood used for barrels,

drums and boxes. Tall straight trunks were used for masts. Fruit eaten in times of scarcity. Wood used for yokes of bullock carts, ploughs, pattern wood and for veneering.

Pongamia pinnata Pierre
FABACEAE
Tamil : Pungam; English: Indian Beech tree; Sanskrit : Karaja; Telugu : Pungu

Commonly cultivated in parks and avenues. Leaves often show insect galls. Leaflets elliptic to ovate. Flowers pinkish. Flowers February to May. Fruits throughout the year. Wood used for cartwheel. Oil is extracted from the seeds which has medicinal use. Now the tree is grown as a bio-diesel yielding tree. Move is on to grow this tree in large numbers through out Tamilnadu.

Psidium guajava Linn.
MYRTACEAE
English : Common Guava; Tamil : Koyya; Hindi : Amrud; Sanskrit : Mansala

Trees grows up to 6m tall. Leaves oblong, elliptic. Flowers white. Commonly cultivated around houses. Flowers April-July. Fruit June-October. Fruits edible. Grown as an ornamental plant. Cultivated for its edible juicy fruits. Fruit is a simple dry many seeded and many loculed indehehiscent fruit with a tough pericarp. The inflorescence is 'Cyme'.

Seeds yield fatty oil. Leaves contain an essential oil used as a flavouring agent. Bark used for tanning. The fruit is cooling and laxative.

Punica granatum Linn.
PUNICACEAE
English : Pomegranate; Tamil : Madulai; Hindi : Anar; Bengali : Dalim

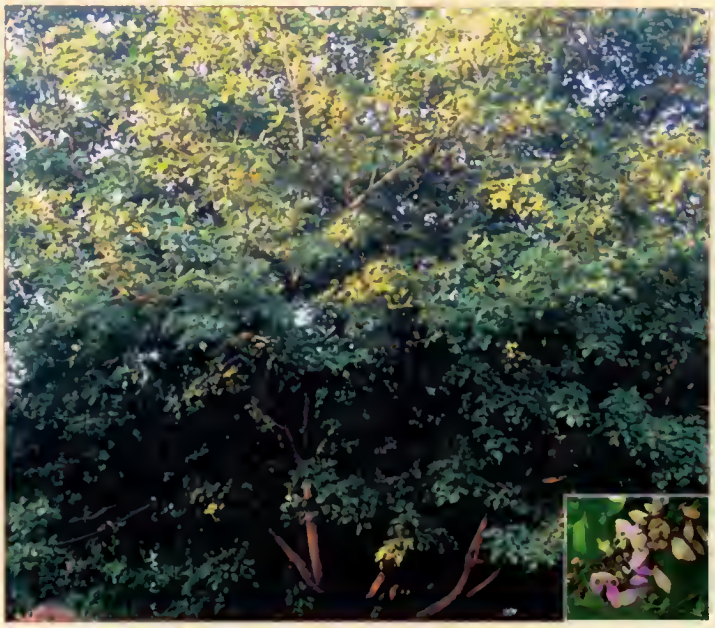
The fruit is a good source of sugar and Vitamin C and a fair source of iron. Flowers yield a red dye. Flower buds used in bronchitis.

Ravenella madagascarensis Sonn.
MUSACEAE
English : The Traveler's Palm; Tamil : Viziri vazhai

Occasionally cultivated around houses. Common in garden. Flowers and fruit during December to March. Stalk of leaves used for walls of hut. Leaves used for roofing and as packing material. Sugar is extracted from the sap.

Rivina humilis Linn.
PHYTOLOCACEAE
English : Blood berry

Shrubs grow up to 80 cm tall. Leaves lanceate to ovate. Flowers white in terminal and axillary racemes. Fruits 3m across. It is a weed of waste places. It is used as febrifuge. Berries yield a red dye.



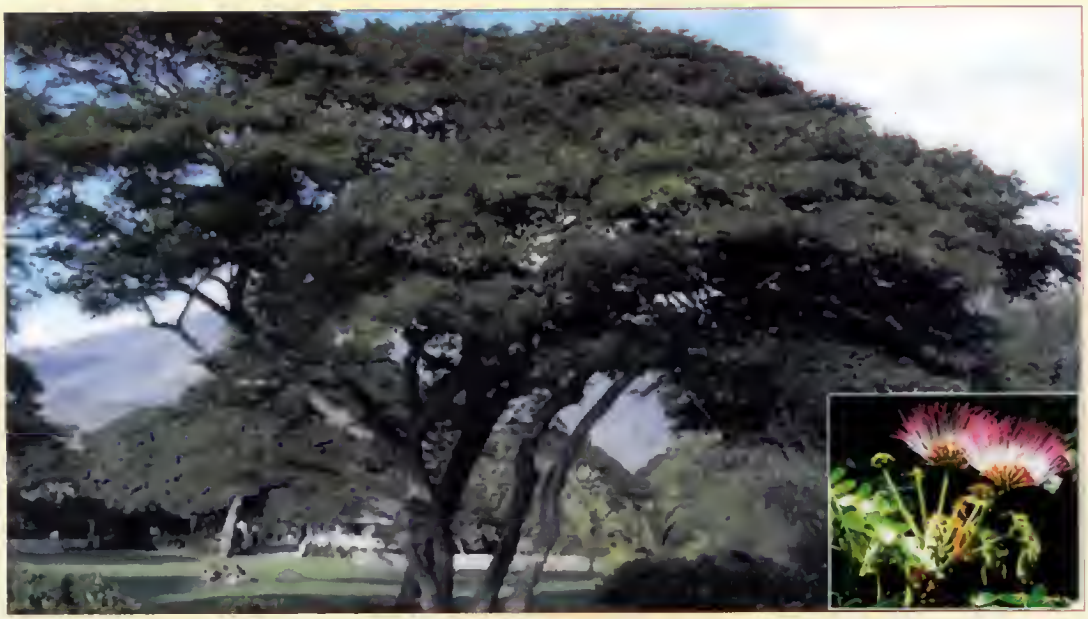
Pongamia pinnata

Psidium guajava

Punica granatum

Ravenella madagascarensis

Rivina humilis



Samanea saman

Sapindus emarginatus

Scilla hyacinthiana

Swietenia mahagoni

Syzygium cumini

Samanea saman Merrill.

MIMOSACEAE

English : The Rain tree; Tamil: Thoongu moonchi maram

Trees up to 16 m tall and grown as avenue tree along roadside. Leaves bipinnate; pinnae 3-5 pairs. Leaflets 2-5 elliptic to obovate. Commonly cultivated along parks and roadsides. Native of Central & South America. Trees yield a gum which swells in water in to a tough cartilage like mass. Leaves and pods used as fodder. It is a shade giving tree. The pulp of the pod is sugary.

Sapindus emarginatus Vahl.

SAPINDACEAE

Tamil : Puchaa; English : The Soap nut tree

Distributed in Sri Lanka, Burma. Tree grows up to 15 m tall. Leaflets in 3 pairs. Petals white flower October to January, fruit December.

Scilla hyacinthiana (Roth) Macb.

LILLIACEAE

Tamil : Narivengayam, Kattuvelvengayam; English : South Indian Squill;

Malayalam : Kanthena

Herb with underground bulb. Leaves linear to lanceate, elliptic. Flowers greenish purple. Capsules subglobose. A weed of open grounds, also in scrub jungles. Fairly common. Flowers and fruit July to August. It is used as an expectorant, cardiac stimulant and diuretic.

Swietenia mahagoni Jacq.

MELIACEAE

English : The Mahagoni tree

Native of tropical America. Tree up to 15 m tall. Leaflets lanceate-falcate. Flowers white in axillary panicles. Capsules woody. Occasionally cultivated in parks and avenues. Flowers March-May. Fruits throughout the year. Timber valued for furniture. Wood used for piles, furniture and plywood.

Syzygium cumini (Linn). Skeels

MYRTACEAE

English : Jaman, Jambolan Black Plum, Java Plum; Tamil : Naaval

Distributed in the subtropical and tropical region. Flowers bracteate. Pollination entomophilous. Decoction of bark and powdered seeds are used to cure diabetes. Large trees or shrubs. Leaves glandular and has insect galls. Ripe fruits edible, and also used for making jams, squashes and jellies. Blossoms are source of honey. Tassar silkworms feed on foliage. Leaves are used as fodder for cattle.

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Tamarindus indica Linn.
CAESALPINIACEAE
Tamil : Puli; English : The Tamarind tree; Kannada : Amli; Hindi : Imli

The tree is a native of tropical Africa. Introduced in India. Leaves paripinnate. Leaflets 15-20, oblong. Commonly cultivated along roadsides and near houses, also runs wild. Fruit used for sauces and curries. Pulp has antiseptic properties. Tree valued for its timber. Flower June to August. Fruit August to May. Pods oblong. The velvety brown pods are sausage shaped. Mesocarp pulpy (with8-10 seeds)extremely sour and sweetish when fully ripe. Wood used in making agricultural implements.

Tamarix aphylla Linn.
TAMARICACEAE
Tamil : Shivappu-ayru-shavukku; Hindi : Lal-jhav; Telugu : Errashirisaru; Bengali : Raktajhav

Wood is used for ploughs, wheels, framework of beds, employed for screws of mills and presses, brush backs, broom handles and for house building and for general carpentry work. Bark and galls used for tanning and as mordant in dyeing. Green leaves and fruits used as fodder.

Tecoma stans (Linn). H.B. & K.
BIGNONIACEAE
Tamil : Sonapatti; Telugu : Pachagotla

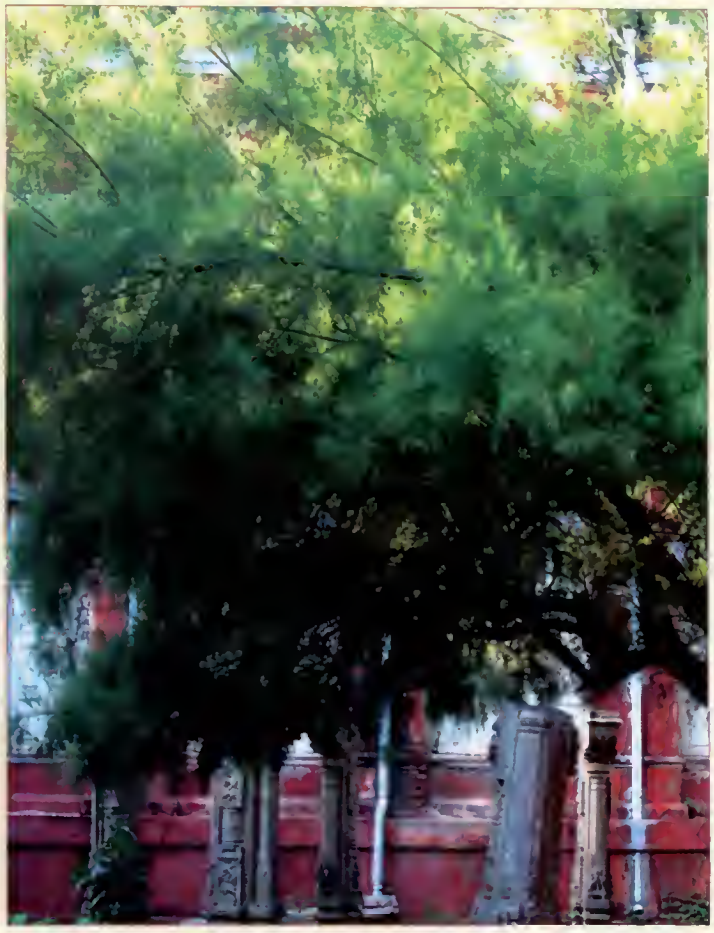
Native of tropical America. Shrubs up to 6m tall. Leaves impari pinnate. Leaflets 3-7. Flowers yellow in terminal racemes and showy. Seeds are winged. Commonly cultivated in gardens and parks. Flower November to April. Fruit March-June. Timber yielding plant. Leaves contain the alkaloid 'tecomine' and 'tecostanine' which are potent. Seeds contain fatty oil. Roots

Tectona grandis Linn. f.
VERBENACEAE
Tami : Tekkumaram; English : The Teak; Hindi : Sagun; Telugu : Adiviteeku, pedda teeku

Trees up to 18 m tall. Leaves obovate-elliptic.flowers white in terminal panicles. Capsules inflated. Wood durable, resistant to fungi, used for beams, window frames, paneling, cabinet making, wagons railway carriages. Sawdust used for chipboards and fibre boards. Leaves contain tannin and dye. Flowers and seeds considered diuretic. Root bark used for coloring matting.

Since teak is resistance to chemicals, it is used in chemical industry. Wood waste and sawdust used for fibre board and plastic board; Leaves used for thatching; Oil applied to eczema.

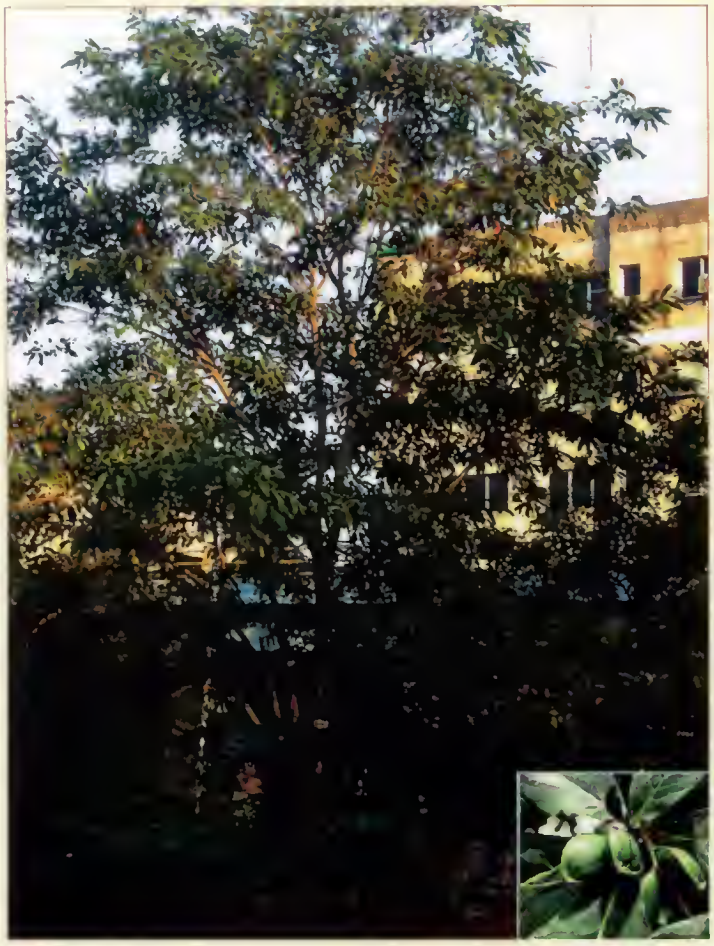
Tamarindus indica



Tamarix aphylla

Tecoma stans

Tectona grandis



Terminalia arjuna

Terminalia bellerica

Thespesia populnea

Wrightia tinctoria

Terminalia arjuna Wight & Arn.

COMBRETACEAE

Tamil : Vella matta Pillamaruthu; Sanskrit & Hindi : Arjuna; Telugu : Yerramaddi

It is a tall tree. Stem solid and contain tannin. It is an ornamental valued tree. Leaves 6-14. Flowers cream colored in terminal and axillary spicate panicles. Flower April-June. Fruit June-December. The bark and fruit used as dye & tans. The bark is highly valued as a cardiac tonic. Pulverized bark gives relief in hypertension. Wood used for carts, agricultural implements water troughs and boat-building. Juice of the leaves used in ear-ache and fed to tasar silk worms.

Terminalia bellerica Roxb.

COMBRETACEAE

English : Belleric myrobalan; Tamil : Tani; Sanskrit : Bahira; Hindi : Bahera

Trees that grow up to 10m tall. Leaves 6-12. Flowers in axillary spikes. Fruits subglobose. Occasionally cultivated in gardens and park. Flower April-May. Fruits May-August. Wood used for carts and rough shafts, for rafters, boards. Fruit called 'myrobalan' is used for tanning. Kernel yields inedible oil, used for soap manufacture. Bark diuretic. Ripe fruits used as an astringent.

Thespesia populnea Soland. ex Correa.

MALVACEAE

English : The Portia tree, Umbrella tree, Indian Tulip tree; Tamil : Poovarasam; Sanskrit : Ghardha bhanda; Telugu : Gangaraavi

Tree that grows up to 10m tall. Leaves cordate. Flowers yellow. Often cultivated as avenue tree. Flowers and fruit throughout the year. Toys, pencils and match sticks are manufactured from the wood. Bark, root, and fruit are astringent. Seeds purgative. Flowers and fruit yield a yellow dye. Fibre used for cordage.

Wrightia tinctoria R. Br.

APOCYNACEAE

English : Pala Indigo plant; Sanskrit : Hyamaraka; Tamil : Vetpalai, irumpalai, Thonthapalai, Palai; Hindi : Indrajau

Tree that grows up to 10m tall. Leaves 6-15, elliptic. Flowers white in color. Common in jungle and waste place. Flowers April-June. Fruit May-September. Wood used for making cups, plates, combs, penholders and for frames and screens. Leaves used as Bidi wrappers. A blue indigo dye called as 'Mysore Pala Indigo,' is obtained from the leaves. Chennapatna toys and idols are made out of the wood. Used for printing blocks. Juice of the raw fruit is used for coagulating milk.

Bark and seeds used in flatulence and bilious problems. Seeds are anthelmintic. Latex used in code wire insulations, floor furnishing and adhesives

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SPECIES DIVERSITY IN *OCIMUM*

Dr. (MS) Geradette Davey*

Introduction

The genus ***Ocimum*** belongs to family *Lamiaceae.* It is distributed in the tropical and subtropical regions of the world. Species of ***Ocimum*** are collectively called basil (Simon et al., 1990). ***Ocimum*** is a genus of important economic and medicinal herbs yet, its taxonomy and nomenclature are in a state of confusion (Paton et al., 1992). This is due to the following reasons:

- The circumscription of ***Ocimum*** is problematic.
- Estimates of species number vary from 65 to 160.
- The same species is referred to by more than one name.
- Each species has several varieties.
- Each species has several chemotypes.

Morphological characters are not always sufficient to accurately delimit each taxon. In the present work a detailed study on the pollen grains of 5 different species of ***Ocimum*** commonly available in Southern India has been made. The 5 species are:

- ***O. americanum*** L.
- ***O. basilicum*** L.
- ***O. filamentosum*** Forssk.
- ***O. gratissimum*** L.
- ***O. tenuiflorum*** L

Biological diversity has become an area of prime interest today with species diversity as one of its integral components. The aim of this paper is to illustrate species diversity in ***Ocimum*** with reference to its pollen characters.

Materials and Methods

Pollen grains were collected from fresh flowers of 5 species of ***Ocimum.*** Pollen slides were prepared by the acetolysis method (Erdtman & Erdtman, 1933). The pollen grains were analyzed under Nikon-Labophot microscope (40x objective and 5x ocular) fitted with a Nikon 35mm camera. All the pollen photomicrographs were magnified 1000 times.

Results and discussion-Pollen morphology

O. americanum

Monad, isopolar, radially symmetrical, hexazonocolpate, semitectate, reticulate .P 35.5 μ (30 - 37.5μ), E 46.25 μ (40 – 50 μ). P/E 0.77,suboblate. Ectoaperture L 34 μ (30–37.5μ), W 4.25μ (3.75 – 5 μ).

Intercolpal distance 16.5 μ (15–17.5 μ).Mesocolpal distance 10.25 μ (7.5–12.5 μ) Apocolpal distance 17 μ (15–20 μ). Exine 5μ , Sexine 3.5μ (2.5–3.75 μ), Nexine 1.5μ (1.25–2.5 μ).

O.basilicum

Monad, isopolar, radially symmetrical, hexazonocolpate, semitectate, reticulate.P 41 μ(35 – 45 μ), E 57.25 μ(52.5–60μ). P/E 0.84, suboblate.Ectoaperture L 30.5 μ (27.5 – 35 μ), W1 μ. Intercolpal distance 22 μ (20–25μ).Mesocolpal distance 8μ (5–10μ). Apocolpal distance 16.5μ (12.5–22.5 μ). Exine 5.25μ (5– 6.25 μ), Sexine 1.38 μ (1.25 – 2.5 μ), Nexine 3.88μ (3.75–5 μ)

O.filamentosum

Monad, isopolar, radially symmetrical, hexazonocolpate, semitectate, reticulate. P 57.6 μ (54 – 64 μ), E 46.5 μ (44 – 48 μ). P/E 1.24, subprolate. Ectoaperture L 36.4 μ (33.63 – 41.89 μ), W 1.65 μ (1.18 – 2.36 μ). Intercolpal and Mesocolpal distances 14.8(14 – 18 μ),Apocolpal distance 17.8 (14 – 22 μ). Exine 3.84 μ (2.95 – 4.72 μ), Sexine 3.07 μ (2.36 – 3.54 μ), Nexine 0.77 μ (0.59 – 1.18 μ).

O. gratissimum

Monad, isopolar, radically symmetrical, hexazonocolpate, semitectate, reticulate. P 36 μ(32.5-37.5 μ), E 46.25μ(37.5-50μ). P/E 0.78, suooblate. Ectoaperture L 33.5μ (30–37.5μ), W 6μ (5–7.5μ). Intercolpal distance 12.5μ (10–15μ). Mesocolpal distance 8μ (7.5–10μ).Apocolpal distance 12μ (10–15μ). Exine 5.13μ (5–6.25 μ) , Sexine 3μ (2.5–3.75μ), Nexine 2.13μ (1.25– 2.5 μ).

O.tenuiflorum

Monad, isopolar, radially symmetrical, hexazonocolpate, semitectate, reticulate . P 43.75 μ(40 – 50 μ), E 51 μ(45 - 55 μ). P/E 0.86, suboblate. Ectoaperture L 36 μ (27.5 – 47.5 μ), W 4.63μ (2.5 – 5 μ). Intercolpal distance 19.5 μ (15 – 22.5 μ).Mesocolpal distance 11.75 μ (7.5–15μ).Apocolpal distance 22μ (20–25μ). Exine 4.63μ (3.75–6.25μ), Sexine 2.88μ (2.5–3.75μ), Nexine 1.75 μ (1.25 – 2.5 μ).

Few systematically related pollen morphological studies are available. Notable exceptions include Sinha & Jee (1980) and Harley et al. (1992). The palynological descriptions given above have highlighted the differences that exist in the pollen of different species of the same genus. The pollen of ***O.filamentosum*** was found to be elongated in shape while the remaining 4 species were found to be orbicular. Based on the differences observed in the present study, an indented key has been prepared which may be used in the identification of species.

An indented key to species of ***Ocimum*** based on pollen morphological studies.

1.Pollen subprolate.....***O.filamentosum***

1. Pollen suboblate

2. Ectoaperture 1 μ wide.....***O.basilicum***

2. Ectoaperture > 1 μ wide:

3.Apocolpal distance 10-15 μ.....***O.gratissimum***

3. Apocolpal distance 15-25 μ:

4. Polar diameter 30-37.5μ.....***O.americanum***

4. Polar diameter 40-50μ.....***O.tenuiflorum***

- In ***O.filamentosum*** the pollen was subprolate.
- In ***O.americanum, O.basilicum, O.gratissimum*** and ***O.tenuiflorum,*** the pollen were subolate.
- The ectoaperture was 1μ wide in ***O.basilicum***.
- The ectoaperture was >1μ wide in ***O.americanum***, ***O. gratissimum*** and ***O. tenuiflorum.***
- The apocolpal distance was 10-15 μ.
- The apocolpal distance was 10-25 μ in ***O.americanum*** & ***O.tenuiflorum***.
- The polar diameter was 30-37.5 μ in ***O.americanum***.
- The polar diameter was 40-50 μ in ***O.tenuiflorum***.

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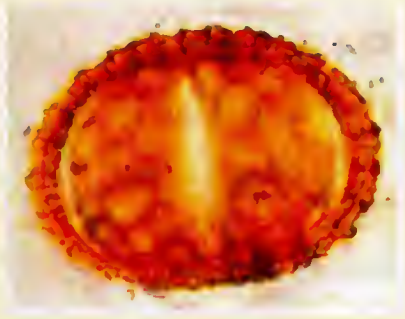
POLLEN MORPHOLOGY OF *OCIMUM*

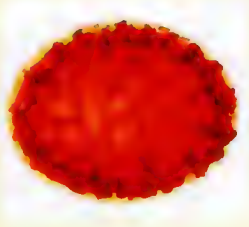
O.americanum

O.basilicum

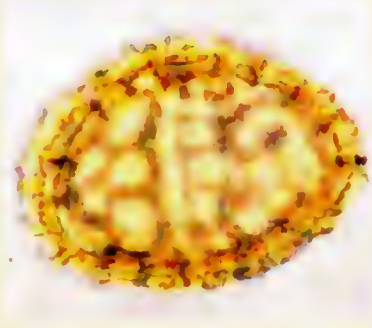


O.filamentosum

O.gratissimum



O.tenuiflorum



TREE DIVERSITY-PREVALENCE, PROMISES, PROBLEMS AND PROTECTION

Ms. R. Pauline* & Dr. Mrs Ridling Waller*

Biodiversity refers to the totality of genes, species and ecosystems in a region. Biodiversity is the recent international buzzword and it also means the variability among living terrestrial, marine and other aquatic systems and the ecological complexes of which they are part of like diversity within species, between species and of ecosystems.

Based on the richness of biological diversity, India is declared as one of the sixteen mega diversity countries of the world and shares about 80% of the estimated global diversity. Among the different classes of plants, the angiosperms constitute an extremely diverse group of vascular plants. There are about 2,35,000 to 3,00,000 species. Another 5,00,000 species are estimated to be present awaiting discovery. Angiosperms are the most recent group of plants to evolve in geological history, having made their probable first appearance around 35 million years ago. These flowering plants are grouped in about 17,0000 genera and the families *Orchidaceae* with 25,000-35,000 species and *Leguminosae* with about 15,000 species are the largest families among angiosperms.

The trees in Women's Christian College Campus display an astonishing diversity of plant life that brightens the college with hues and fragrance from all over the globe, some of them indigenous to Mexico, Africa, Tropical America and Australia. About 105 tree species have been catalogued in the WCC Campus which stands in a sprawling twenty acres of land in the heart of the city. Some of the interesting tress on campus include

- *Adenanthere pavonina* – Red Bead tree which is an excellent nitrogen fixer
- *Averrhoa carambola* – Star fruit tree which yields edible fruit and carambola juice
- *Bombax ceiba* – Red silk cotton tree which yields silk cotton fibres
- *Brownea grandiceps* – An excellent ornamental tree from Venezuela
- *Calophyllum inophyllum* – Oil extracted from nut is used in cosmetic industry
- *Cananga odorata* – Fragrant oil extracted from the flowers is used in perfume industry
- *Cassia fistula* – An ornamental tree resembling the English Laburnum
- *Cassia javanica* – An excellent ornamental tree from Java which displays a riot of hues
- *Couroupita guaianensis* – Cannon ball tree grown in sacred groves
- *Cycas circinalis* – a Mesozoic relic and an endangered Gymnosperm tree
- *Delonix elata* – The white gulmohr which has anti-rheumatic properties
- *Ficus glomerata* – The cluster fig tree yields edible vegetable
- *Filicium decipiens* – False fern tree which yields durable wood

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- *Guaiacum officinale* – The wood of life tree which yields valuable timber
- *Holarrhena antidysenterica* – The tree has anti-dysentery properties
- *Kigelia africana* – Sausage tree pollinated by bats
- *Lagerstroemia reginae* – The salt tolerant wood used for ship construction
- *Peltophorum pterocarpum* – The exotic rust shield bearer, an avenue tree.
- *Pseudobombax ellipticum* – Shaving brush tree which is rare and ornamental
- *Pterocarpus santalinus* – An economically important red saunders tree
- *Saraca asoca* – Asoka tree that has many medicinal properties
- *Spathodea compunulata* – An African tree which is bird pollinated
- *Tectona grandis* – Teak tree has timber significance
- *Wrightia tinctoria* – The wood is used for making channa patana toys

Benefits

Trees are indicators of a community's ecological health. The greater the tree cover, the more are the ecosystem benefits in terms of reducing storm water runoff, increasing air and water quality, storing and sequestering atmospheric carbon and reducing energy consumption due to direct shading of residential buildings. The trees yield

- **social benefits** since their stature, strength and endurance given them a cathedral like quality
- **communal benefits,** for trees often serve several architectural and engineering functions for a community
- **environmental benefits** because trees alter the environment in which we live by moderating climate, wind speed, improving air quality, conserving water, and harboring wildlife. Trees intercept water, store some of it, and reduce storm runoff and the possibility of flooding.
- **economic benefits** in terms of timber, fuel, food, feed and other tree products.

Depletion

As per the latest State of Forest Report 2003 of Forest Survey of India, the forest cover of Tamilnadu is 22,643 sq.km which is 17.41% of the Geographical Area of the State. However the forests are depleted in such a place that many valuable tree species are lost. Currently, over 40,000 species of plants, animals and fungi are regularly exploited for human benefit. The main reasons for depletion of trees are:

- Overexploitation and over utilization
- Deforestation
- Agro forestry
- Poaching

- Conversion into graze lands
- Encroachments
- Pollution
- Urbanization
- Industrialization
- Pests and Diseases

Conservation

Of the 270,000 known species of higher plants, 34,000 are endangered. Nearly, 30% of the 16,000 known plant species are at risk of extinction. In the tropics ecosystem destruction is so severe that some 60,000 plant species, roughly one-quarter of the world's remaining total, could be lost within 25 years. The importance of trees to our quality of life requires that we protect them. Citizens and communities must adopt and enforce sound policies and regulations that will protect the scenic, environmental and economic benefits of trees. Few strategies adopted to conserve trees are

- Conservation of **genetic diversity** through gene banks, DNA and Genome libraries
- Conservation of **species diversity**
- **In situ Conservation:** Declaring biodiversity sensitive areas as protected areas, biosphere reserves, and hot spots.
- **Ex-citu Conservation** : Germplasm collections, Botanical gardens, Seed banks and Pollen banks
- **In-vitro Conservation methods:** Meristem tips, buds and callus usually referred to as "synseeds" are stored.
- **Conservation of ecosystem** diversity through reintroduction strategies

Trees and Natural Calamities

Trees can regulate the flow of flood water thereby reducing the risk of inundation. But a recent squall and a flood resulted in the loss of about 200 huge avenue trees in the city mainly due to their exotic nature and improper post-planting care due to heavy urbanization. The main casualties during the squall and flood were *Delonix regia* (native to Madagascar), *Peltophorum pterocarpum* (native to Malaysia) and *Tabebuia rosea* (native to Mexico). It is recommended that indigenous trees are planted as avenue trees and proper root space is given for appropriate anchorage so that they don't get uprooted in times of natural calamites.

Trees can also act as bio-shields and buffer zones and it has been reported that the magnitude of the tsunami devastation could have been considerably reduced if natural barriers such as mangroves and

other trees like *Casuarina equisetifolia, Thespesia populnea, Terminalia catappa and Calophyllum inophyllum* were raised along the coast. *Casuarina* trees saved this Nagai hamlet, Naluvedhapathi, 15 km from Vedaranyam. About a year ago, its residents and the district administration set a Guinness record of planting about 84,200 *Casuarina* saplings along a stretch of two kilometers along the coast, thereby alleviating the high impact of the tsunami in this area.

Chennai exhibits a wide diversity of trees both exotic and indigenous, that play a significant role in mitigating the green house effect, attracting local and foreign bird migrants like golden orioles, ibises, pelicans, storks, darters, flamingoes, herons etc., and also in providing timber and other economic and environmental benefits to the community. Therefore it is our prime duty to protect our tree wealth and also to create awareness about the prevalence and the promising virtues of their beauty, flamboyance, habitat for wildlife etc., The need of the hour is to express our concern over the illegal depletion and cutting of trees and ensure that we enhance the tree diversity in Chennai in terms of number and variety.

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PLANT BIODIVERSITY OF SACRED GROVES IN PONDICHERRY AND ITS ENVIRONS

Dr. V. Krishnan*

Introduction

Sacred groves are one of the finest examples of people's initiative in conserving native biodiversity. They are patches of natural vegetation demarcated by ancient societies and protected on the basis of religious practices and cultural traditions. They are distinct segments of various landscapes containing trees and other forms of life and geographical features.

Sacred groves have been described variously and natural museums of giant trees, treasure houses of threatened species, dispensaries of medicinal plants, regulators of water-shed, recreation centres for urban life, veritable gardens for botanists, gene banks of economic species, a paradise for nature lovers and a laboratory for environmentalists.

Sacred groves have been identified all over the world and in all shades of cultures. In India, the groves have been reported from the forest ranges in the hills, leeward arid regions of the deserts and the agricultural plains as well (Ramakrishnan et al – 1998). Whereas larger groves are considered mini-biosphere reserves, the smaller ones are also of biological value as they harbour some old and magnificient specimen of trees and climbers (Gadgil and vartak 1975).

A systematic survey of the sacred groves of India in 1997 has recorded the existence of thousands of such groves along the plains and hill. Meher-Homji(1986) reported the protection conferred by a termite mound protecting a forest patch at Puthupet near Pondicherry. The biodiversity and forest structure of several sacred groves in Pondicherry region have been reported recently (Ramanujam and kadamban 2001). As many as 163 groves have been enumerated and their status has been assessed on the basis of their appearance and composition (Krishnan et al 2004).

We studied the patterns of belief system and sand structure of fifteen groves, with the objective of understanding the linkage between culture and conservation of biodiversity. This paper describes the floristic richness and vegetation analysis of these groves and high lights their botanical significance.

Study Area

The study area is located on the south-eastern coastal belt called coromandal coast of south India along the Bay of Bengal. This extends from Ramanathapuram in south Tamil Nadu to Visakapattinam in Andra Pradesh. This belt harbors several pockets of dry evergreen forest vegetation (Champion 1936),

some of which are maintained as sacred groves (Parathasarathy and Karthikeyan 1997). The present study area is a tract of ca. 110 × 40 Km^2 in which Sandhikuppam grove (Sk), Keezhkumaramagalam grove (Km) , Sedarapet grove (St), Karasur grove (KS), Ramanathapuram grove (RP) Nagari grove (NG), Kumalam grove (KU), Silkaripalayam grove (SL), Pannaikuppam grove (PA), Krishnavaram grove (KV), Nattamedu grove (NM), Moorthikuppam grove (MK), Thennampakkam grove (TP), Mangalam grove (MM) and Adamarathuppam grove (AA) are located. Seven of them fall within Pondicherry territory ; four each occur in the intervening pockets of Cuddalore and Villupuram Revenue Districts of neighbouring Tamil Nadu state.

Methods

Bio-diversity analyses

Floristic composition of each grove was analysed during field visits staggered over different seasons; namely post-monsoon (January to March), summer (April to June), pre-monsoon (July to September), monsoon (North-East) (October to December) .

Flowering twigs were collected and identified taxonomically using the publications of Gamble and Fischer, Henry *et al* and Mathews .

Vegetation analysis

Plots of 20 m X 20 m size were laid in each grove for studying the vegetation . depending upon the size of the grove , the number of plots ranged from 5 to 25 in each site .

Phytosociology

Following Murphy and Lugo,trees and lianas measuring >20 cm girth at breast height (gbh) were enumerated and the phytosociological parameters , viz. density , basal area (BA) , and biovolume (BV) were determined as per Cottam and Curtis

Result

Of the 15 groves Sedarapet with its uniconic character and close tree cover comes to an informal grove. Thennampakkam is dedicated to the memory of Saint Azhagar Siddhar; hence a memorial grove, all others are formal groves , since the idol worship and shrine construction is prevalent in varying extent.

Sedarapet (0.23 ha) is the smallest one , but had 60 species in 56 genera and 36 families . Of these ,21 are tree species, 14 shrubs , 17 herbs, seven climbers and one parasite.

Karasur (0.25 ha) had a total of 32 species distributed in 30 genera and 23 families . There were nine woody species, eight shrubs, seven herbs, seven climbers Cassytha *filiformis* was the only parasite.

The grove at Moorthikuppam (0.28 ha) contained 24 species belonging to 23 genera and 19 families . Among these , eight were woody species , shrubs and herbs seven each and two lianas . A rare woody climber *Vallaris solanacea* was recorded only in this grove.

Nagari grove (0.28 ha) had a total of 30 species representing 29 genera and 19 families . Of these 15 tree species, 5 herbs, 8 herbs, and a single climber were enumerated.

Kumalam grove (0.30 ha) contained 27 species in 25 genera and 20 families . Of these trees were 18 , shrubs three , herbs five and climber one.

Keezhkumaramanagalam (0.32 ha) had a total of 40 species , representing 36 genera and 27 families. There were 22 woody taxa, 10 shrubs, 5 herbs, 2 climbers and one liana.

Ramanathapuram (0.66 ha) recorded 56 species in 54 genera and 35 families . There were 21 woody taxa, 12 shrubs , 15 herbs and 7 climbers.

At Silkaripalayam (0.75 ha) 74 species , 70 genera and 40 families were enumerated. Of these, 23 woody taxa, 19 shrubs, 24 herbs, 8 climbers were found.

The grove at Mangalan (0.96 ha) had a total of 64 species, in 59 genera, and 37 families .

Sandhikuppam (1.2 ha) had 57 species distributed in 53 genera and 36 families.There were 15 tree species, 13 shrubs, 19 herbs, 8 climbers and 1 liana.

Nattamedu (1.5 ha) had a total of 65 species in 59 genera and 37 families inclusive of 30 woody species, 15 shrubs, 14 herbs, 4 climbers, liana and parasite one each.

The grove at Pannaikuppam (1.5 ha) had 55 species, 48 genera and 36 families, which includes 23 woody species ,12 shrubs , 13 herbs, 6 climbers and 1 parasite.

Thennampakkam (4.5 ha) is famous for the temple of Azhagar and is a memorial grove. It had a total of 23 species distributed in 21 genera and 18 families; 15 are woody species, 4 shrubs, 3 herbs and 1 liana.

Table 1 : Habit-wise distribution of species in 15 Groves

No.	Grovename	Size ha	Total Plants			Trees		Shrubs		Herbs		Climbers		Lianas		Parasites	
			Sp.	Ge	Fam	Sp.	Fam	Sp.	Fam	Sp.	Fam	Sp.	Fam	Sp.	Fam	Sp.	Fam
1.	SK	1.12	57	53	36	15	14	13	10	19	15	8	6	1	1	-	-
2..	KM	0.32	40	36	27	22	17	10	9	5	4	2	2	1	1	-	-
3.	SU	0.23	60	56	36	21	17	14	11	17	13	7	6	1	1	-	-
4.	KS	0.25	32	30	23	9	8	8	6	7	6	7	7	-	-	1	1
5.	RP	0.66	56	54	35	21	16	12	11	15	12	7	6	-	-	-	-
6.	NG	0.28	30	29	19	15	12	5	5	8	6	1	1	-	-	1	1
7.	KU	0.30	27	25	20	18	14	3	3	5	5	1	1	-	-	-	-
8.	SL	0.75	74	70	40	23	14	19	14	24	18	8	7	-	-	-	-
9.	PA	1.50	55	48	36	23	14	12	9	13	11	6	6	-	-	1	1
10.	KV	8.80	92	81	41	29	17	25	14	19	13	16	10	1	1	2	2
11.	NM	1.50	65	59	37	30	18	15	14	14	10	4	4	1	1	1	1
12.	MK	0.28	24	23	19	7	7	7	7	7	7	2	2	-	-	-	-
13	TP	4.50	23	21	18	15	13	4	4	3	3	-	-	1	1	-	-
14.	MM	0.96	64	59	37	24	17	14	12	17	12	5	5	2	2	2	2
15.	AA	4.92	79	60	36	28	17	15	9	22	11	10	5	2	2	2	2

Discussion

A total of 200 species belonging to 176 genera and 62 families have been enumerated from 15 groves covering 26.37 ha from the present study. Of these 137 are woody species which is floristically significant (Table 1). Three of 15 groves were mono-species roves i.e., pure stands. Yet, the presence of other species, though in limited number, in the palm and tamarind groves must have resulted from subsequent introduction, ostensibly under economic or religious considerations. A few of them have become numerous gaining significant IVI.

The sandal wood tree, *Santalum album*, which is an evergreen tree and endangered taxon. It has found an asylum in Sedarapet grove. A robust specimen of *Polyalthia suberosa* measuring 8m × 28 gbh has been recorded in Pannaikuppam grove. Likewise , a magnificent specimen of *Pamburus missionis* (20m × 155cm gab) occurs in Kumalam .

Among the figs, one at Keezhkumaramangalam is the largest (18m × 20m gbh) and covers 1.5 acres. Three gaint lianas viz. *Capparis zeylanica* (28cm gbh) in Ramanatha-puram, *Derris scandens* (83cm gbh) in Mangalam, and *Leptadenia reticulata* (33cm gbh) in Karasur were also recorded.

Salvadora persica (5m × 156 cm gbh) a salt-tolerent species thrives well in Alamarathukuppam grove. *Sarcostemma intermedium*, the leafless Xerophyte found in the above grove. *Corypha macropoda*, a monocarpic palm, occurs at Krishnavaram and Alamarathukuppam. A rare species *Amorphophallus sylvaticus* is located in karasur grove.

Cretaeva adansonii, categorized as occasional in occurrence by Gamble (1935) has now become rare in the wilderness. Its presence in Ramanathapuram and Alamarathu-kuppam becomes significant. *Gloriosa superba* a tendril climber classified as threatened species (FRLHT 2003) is found in Silkaripalayam.

We recorded only one non-flowering plant, *Riccia sp.* The thalloid bryophyte colonises the moist and shady niche provided by the *Capparis* dominated thickets at Krishnavaram.

Concluding Remarks

Despite the cultural and religious practices protecting the groves, evidences of human impacts which are threatening their existence and survival. The invasion of exotic species like *Prosopis glandulosa* and *Lantana camara* in Krishnavarma, Nattamedu, Pannaikuppam, groves and encroachment of grove proper for agricultural, clay mining, sand quarying and erection of elaborate temple structures indicate the slackening of the religious hold on people.

The present study has confirmed the existence of rich biodiversity in the groves and justify the ecological prudence of the agricultural peasants of the past. Their cultural traditions have protected scores of plants of conservation values either within the relic patches or in the anthrotropic stands. A treasure trove of biodiversity has been identified in the form of scared groves and it craves for very urgent protection from civilized society.

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IV. VALUES USES AND PROTECTION OF BIODIVERSITY

APPLICATION OF VALUES USES OF BIODIVERSITY & LOCATE SPECIFIC STUDY

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Biodiversity represents all living forms on planet earth. The term biodiversity is multi dimensional in character. The present attempt is to focus the values, ethics and uses of biodiversity as the interdisciplinary approach, mainly involving economics and international sociology. Through the international community has developed new area philosophies in this, Indian context, the study is said be infantile stage.

While the values of Biodiversity are studied as the economic values (e.v.) of and the quality of life value (Q.L.V.) prioritised. Similarly by many authors direct values or the direct economic benefits as well the indirect economic benefits are analysed. While the Economic Value of Biodiversity is measurable, it is felt as more difficult to quantify the Q.L.V. In short we may consider the economic value of the discussed biodiversity as quantitative and that of Q.L.V. as qualitative.

Also most often the market value or the trade value of Biodiversity is confused with the economic value of the biological component. To assess the economical value we have considered all the other inputs.

As per Daily and Das Gupta (2001) though there has been a great deal on functional ecosystem, there is a paucity of information about ecosystem economics which deals with supplies of service in general. Very little is known about the marginal values i.e. the cost or profit associated in protecting the loss of any unit of ecosystem.

From the litrature it is understood that linearities and non linearities in ecosystems in response to human impact is not fully studied. Besides the economic characterization of ecological commodities, like private / public are good is not made clear for the Indian conservation biologist. The study on values becomes complicated when biodiversity is treated as the psudonym of over all population in the society. Biodiversity values are really understandable among and specific quarters. Robert Mendelsoh (2001) brings us the following states report.

Biodiversity

1.5 Million species
1.15 Million insects
2,50,000 flowers & Plants
80,000 fungi
10,000 Molluscs
30,000 Vertebrates.

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Other Values of biodiversity

The concept that insist the intrinsic values argues that the plants, animals must also be respected by their intrisic value which are inherent not accorded by their present or future use. This is closely considered with the environmentalist vandhana Shiva's denizenship concept giving equal right to animals, plants, rivers and deserts to live.

Option value of the biodiversity is another economic approach, based on the potential value of the component. The example is any plant with potential for bioactive component.

Besides, the resource economics and environmental economics should be clearly understood. Generally in resource economics the state variables are biomass or population or the small unit of ecosystem. This is a quantifiable method, whereas environmental economics deals about the value of the biodiversity on quality basis, eg pure air, clear water etc.

Most often in Biodiversity study context, the word 'value', is misunderstood with the market price. But it is actual worthyness of the ecological component.

A survey conducted by the journal of environment economics and management says "there is no market which exist for natural resources," since factors like larger geographical area, mobility of the component and the time factor involved. In the biodiversity value studies, the most important economics phenomenon of "externalities" which interact with other part of society with out concern is the difficult part.

Similarly while we discuss about values and uses of biodiversity the social worth of goods and services i.e. the accounting price' (the shadow price) of biodiversity need to be worked out. The social worth of natural resource in based on

(a) Use value of biodiversity
(b) Option value of biodiversity
(c) Intrinsic Value of biodiversity

Environmental Services

While debating about the value of biodiversity Partha Das Gupta (2001) says "biodiversity is essential for its wide variety of services on which human survival depends".

Ethics and Value

Environmental degradation and loss of biodiversity have created a new discipline called environmental ethics. This specify the appropriate human relationship to non human natural world. As it is noted most of the values made in a anthropocentric way is focussed on welfare of human life

materialistically. Hence sacred groove concepts are developed in India advocating value in conservation of nature. The cultural value of conserving the forest is celebrated by the local committes. Eco system integrity is another sensible value where Ecosystem Deep ecology is free from human interference.

Deep ecology is a new approch to promote the values and uses of biodiversity (Primack and cafra *2001) this* concept advocates biocentrive equality and self realization. This school of thought value the following:

(1) Harmony with nature
(2) Natures intrinsic worth
(3) Population stability
(4) Eco friendly life
(5) Limitation of resources
(6) Using appropriate technology
(7) Local control on smaller biodiversity units like water sheds, bioregimes.

While talking about the biodiversity loss John A.H.Annign (1995) says the talking on biodiversity loss is the essential 'career' of global environmental problems". He further says 'unlike the acid rain, global warming and any other cross disciplinary scientific problem, the biodiversity talks buffered against the "issue attention cycle" (Down 1972), which affects other environmental issues'. Let us also value this statement which discusses about the values and uses of biodiversity.

Case Study

RMNH, Mysore

1. Aesthetic Value: Lawns, architecture , location
2. Recreational Value: for general public adult
3. Educational Value: Non formal environmental education centre
4. Economical Value: Open car shed, no pesticide or nature used, no entry fee
5. Religious Value: Tradition conservation of biodiversity exhibits trees and plants in said area plants.
6. Cultural Value: to impart cultural value programmes at pelican village.

Success stories of Bio diversity Conservation Education

At Indian Academy of Science IISC Bangalore Madhav Gadgil (1995) launched 'Life scape' project during the occasion of the birth centenary of Dr. Salim Ali and successfully continued the study on mapping ecological habits and monitoring presentative localities involving teachers and students

from 6000 odd science colleges. Developing hard ware, soft ware and arranging field trial and networking Western Ghat biodiversity research are the objectives of this project, which yield good results in observing the countries biodiversity. This project envisaged no financial support from any other agency. As a part of this project, the Biodiversity registers kept in schools provides lot of information about biodiversity around the schools as suggested by Gadgil (1996).

Similarly, Vivekananda Giri Jana Kalyana Kendra located at B.R. Hills is a tribal educational institution where Soliga students are trained to identify more than 200 species of plants. These local tribe would not collect more than 50% of the yield from any other tree like gooseberry tree here. This is an excellent practice for biodiversity conservation allowing 50% of the mother tree for propagation of the variety. Now this has become a very popular concept among conservators.

Amrithalingam (1998) from CPR Environmental Education Centre studied the sacred groves and trecs of Tamil Nadu to create biodiversity awareness among educational institutions and general public. He visited 300 temples and studied sixty sacred trees and suggested this sort of biodiversity conservation as the value added educational curriculum. Many schools expressed their interest to conduct similar kind of study in their respective area. The cultural element embedded in this project is very appreciable.

The Mysore Amateur Naturalists, an N.G.O. at Mysore created biodiversity conservation awareness by conducting programme for school children through Eco-clubs. In an exercise they understood that rural schools are better informed about the bio resources than urban schools. By the traditional wisdom these village school children could easily identify the medicinal value of *Amaranthus viridis*, *A. spinosus*, *A. tricolour*, *Luffa acutangula*, *Cleome monophylla*, *Portulaca quadrifida*, *Cynodon dactylon*, *Kalanchoe pinnata* and *Boerhavia diffusa*. This simple exercise, to identify the traditional food and medicinal plants has created a greater level of biodiversity awareness among children.

Regional Museum of Natural History, Mysore has created awareness about the biological diversity of Southern States and especially about the Bandipur Tiger Sanctuary, Nagarhole National Park, B.R. Hills Sanctuary among teaching and student communities. They introduced a programme of collecting used clutch wires from areas around sanctuaries, by the school children to prevent them from the easy access of small time poachers who makes snares, nooses out of these clutch wires to poach herbivores and smaller carnivores in Sanctuaries. A simple and effective drive followed by the awareness education, now found to be very workable in conservation. Besides as the part of biodiversity awareness education, RMNH uses street plays, mask making, puppetry and modeling as the tool to convey the message of conservation to teaching community and this has been found to be very effective in imparting biodiversity awareness.

Besides these the role of Centre for Science and Environment, New Delhi, Kalpaviriksh, New Delhi, Navdanya New Delhi, Centre for Environment Education, Alunedabad, Kerala, Sastra Sahithya Parishad, Trivandrum, M.S.Swaminathan Foundation Chennai and Zoo Outreach Organisation, Coimbatore are worth mentioning.

Conclusion

Because of the social relevance, society would be more willing to accept and fund this type of biodiversity awareness education. The interest that may be generated among teaching and student communities by any of the above suggested means would enhance educational, practical and personal value significantly. This sort of biodiversity conservation may add an entirely new dimension keeping genetic resources to human use in the form of food and life saving medicine. Eg. Drosera spp. Recent technical developments have opened up the commercial possibilities to erode world's biological heritage. Let us welcome the charter on corporate responsibilities (G.O.I. 13-3-03) and private-public partnerships to protect our environment and biodiversity. Let us wake up. Let us learn to live and share the resources of the increasingly interdependent single earth by the education and awareness created. Let us understand the values and uses of biodiversity in the real sense and save our own lives.

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THE ROLE OF THE INDIGENOUS PEOPLE IN PROTECTING THE BIODIVERSITY

(As revealed from the case studies of the indigenous people of the Nilgiris)

Dr.C. Maheswaran*

I.Prelude

It is observed that the indigenous people who inhabit a particular biosphere[1] tend to protect its biodiversity [2] in one way or the other, because of the cultural valves they attach usually to the indigenous floral and faunal wealth that surround their habitat. The ethnographic studies carried out among the indigenous people of the Nilgiris have identified the belief systems, the world views[3] and the cultural practices of the indigenous people that effect the protection of the biodiversity either overtly or covertly.[4]

In this paper, an attempt is made to present the roles played by the indigenous people within a biosphere in protecting the biodiversity-through the case studies of the indigenous people of the Nilgiris who inhabit the Nilgiris Biosphere Reserve which is identified as one of the hotspots.

II. Geographical Settings & Ethnological Settings of the Nilgiris: A Brief Note

The Nilgiris highland region of the North West Tamil Nadu which form a massif in the juncture of the eastern and the Western Ghats to the North of the Palghat Gap. Not only rich in biodiversity but with a varied stock of ethnic groups of indigenous category as well. The Nilgiris occupy an area of about 7000 square miles with a central altitude of about 3760'. The Nilgiri Hills raise almost abruptly from the plains of Coimbatore; on the North east, they slope down through lesser ranges towards the 'Kaveri' chain of hills', and on the West to the Kerala uplands.

The Nilgiris is inhabited by 6 indigenous ethnic groups, viz. Todas, Kotas, Kurumbar, Irulas and Paniyas (-on the tribal stock) and Badugas (- on the non-tribal stock). And these indigenous ethnic groups not only occupy different altitudes but also observe varied subsistence economies [5] as detailed below:

i. Todas- occupy the highest altitude – as Herdsmen;
ii. Kotas – occupy the higher altitude, below that of the Todas – as Artisan
iii. Kurumbas – Occupy the middle altitude, below the Todas and the Kotas – as Hunter – Gatherers;
iv. Irulas – occupy the latitude, on par with the Kurumbas – as Hunter- Gatherers;
v. Paniyas – occupy the lower attitude - as Hunter gatherers and
vi. Badugas – Occupy the higher altitude below that of the Todas & and the Kotas – as Cultivators.

III. Case Studies of Indigenous People of the Nilgiris Protecting the Biodiversity

It is interesting to observe that both the material culture and the non-material culture [6] of these indigenous people reflect their immediate biodiversity. And the relevant case studies of the Nilgiris portraying the roles played by them in protecting the biodiversity of their respective habitats are presented here in detail.

Case Study : I

The cultural milieu of the Todas of the Nilgiris is buffalo-centred as they upkeep an indigenous herds of water buffaloes. And these water buffaloes are dichotomized into two sub-sets as 'secular' and 'sacred'. While the herds of the secular buffaloes, are looked after by the Todas (other than the priests) the herds of sacred buffalo are maintained by the priests of the respective Toda hamlets. And the priests of the toda tribes of the Nilgiris keep the arenas where they upkeep the herds of the sacred buffaloes under their care as inaccessible ones, even to the fellow tribal people. And thereby the pristine biodiversity of such areas is protected with very minimal efforts.

The Todas who exploit the grasslands around their hamlets for grazing their buffalo herds observe nomadism around the grass lands in a cycle, leaving ample time span to rejuvenate them in that cycle. And thereby they maintain the twin ecosystem of the Nilgiris, viz. the grasslands and the adjacent shola forest intact.

Case Study: II

The Kota tribes of the Nilgiris have shrines for their male deity 'aynoar' and female deity 'amnoar' in each of their traditional hamlet known as 'koakkaal'. And as they maintain these shrines as inaccessible to the non-Kotas, they could protect the green cover thereby those arenas and thereby the biodiversity of that patch of forestland is protected since time unmemorable.

Case Study: III

In Siriyur, a tribal hamlet of the Irulas (which is situated within the range of the Mudumalai Wildlife Sanctury) the shrine belonging to the Siriyur Mariyamman is worshipped by the Irulas themselves. The patch of forest cover in and around this shrine is considered as its sacred grove. And thereby it is protected by the Irulas. Consequently, the rich dearth of biodiversity of this sacred grove is protected very well.

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Case Study: IV

At the entrance of each and every Baduga hamlet a huge shaped stone structure[7] known as 'akka bakka kallu' is erected. And the non-Baduga people are seldom allowed to cross this structure and treated usually at its vicinity itself. Thus, the wealth of biodiversity that prevails within the domain of the hamlet is protected.

The Badugas include the uprooting of green cover as one of the sins committed by the people in a funerary rite called 'karaharasuvadhu' wherein a calf is set free, having transferred to it the various possible sins that might have been committed by the deceased person. It is worth quoting here that the Badugas even apologies to the 'katte choppu' (, the shrub of 'kurinji') before collecting the withered plants for firewood purposes- at the culmination of blooming.

Case Study: V

In the Kotagiri taluk of the Nilgiris there is a hamlet known as *Banaguidishoa*. Here, a three-tier herostone is deified both by the Irulas and the Badugas who inhabit the hamlets nearby this site. A patch of forest cover, adjacent to the hero stone of Banaguidishola is believed to belong to this hero stone as its sacred grove. And consequently, the biodiversity of this serene green cover is patched both by the Irulas and the Badugas who propitiate the hero stones.

Case Study:VI

At Bokkapuram, an Irula tribal hamlet (that is located in the Kalhatti-Mudumalai Wildlife Sancturary Road) there is a shrine dedicated to the presiding deity, the Bokkapuram Mariyamman. All the indigenous people of the Nilgiris, namely, Todas, Kotas, Kurumbas, irulas, Paniyas and Badugas deify this deity reverently once in a year. The forest cover present in and around the shrine of the Bokkapuram Mariyamman is construed as pristine as it is conceived as a possession of that deity. Accordingly, this patch of green cover and its biodiversity are protected at ease.

IV. Conclusion

The life and culture of the indigenous people are often centered around the endemic flora and fauna that surrounds their habitat. The cultural values they attach to these floral and faunal heritage is such that they are construed as possessing 'anima' (i.e., "spirit") and or as the 'animata' (i.e., "abode of anima"). Even before exploiting them for their judicious consumption as food, fodder or media for fabricating artifacts/craftefacts they are in the habit of observing appeal and or seeking apology for such unavoidable exploitations. And further, they use to give adequate time span for rejuvenation and thereby allow the Mother Nature to restore and maintain its stature in a more meaningful and balanced manner within that time span.

Hence, it is surmised that the roles played by the indigenous people in protecting the biodiversity is on volition and instantaneous and thereby form part and parcel of their cultural milieu.

Foot Notes

[1] The existence of flora, fauna and people in a religion is known as 'biosphere'.

[2] The occurrence of abundant varieties of endemic flora and fauna within a biosphere is referred to as the 'biodiversity'.

[3] The perspectives and interpretations of the indigenous people on the 'Nature' and 'culture' are collectively called the 'world views'. And accordingly, such world views are often understood as 'culture specific'.

[4] Levying of punishments for exploiting and or over exploiting the biodiversity could be treated as steps taken to protect it overtly. On the contrary, construing a patch of green cover as sacred grove could be treated as steps taken to protect it covertly.

[5] Such observance of varied geographical settings and cultural ecological settings by the indigenous people within a biome itself is an excellent exercises of adjustment with Mother Nature so as to ensure balance of nature and food security for all.

[6] Currently, these dichotomized categories are designated as the 'tangible culture' and 'intangible culture' respectively.

[7] In some Baduga hamlets, wooden structures are found to have replaced the erstwhile stone structures.

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BIODIVERSITY AND MUSEUMS

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Biodiversity is the variety and differences among living organisms in terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are a part. Earth is a unique place in the whole universe. As for as the present knowledge is concerned ***life*** is found only on earth. Due to different factors this unique 'life' in the Earth is threatened in the recent past. Many species are getting endangered day by day. Awareness has been created to protect this biodiversity in the Earth. Still general public do not understand the meaning of biodiversity and the importance of its conservation Different methods are adopted to convey the message about the importance of biodiversity to the public.

Importance of Museums : The concept of museums have changed from past to present. Previously the museums were object oriented, but nowadays museums play an important part of education and aid as entertainment centres. The museums differ from school and college curriculum in that the visitors get the opportunity of exposure of interpretation of objects. With modern technological advancements, museums do not require objects at all for its display. Any theme can be displayed in a museum by using museological technique.

What Museums can do : Museums can interpret a subject for easy understanding. In this way the following topics connected with biodiversity may be covered in a museum.

1. Formation of life
2. Evolution of life
3. Biodiversity
4. Importance of life on Earth
5. Threatening factors for the endangerment of life
6. Extinction of life
7. Preventive factors for the extinction

The following media are used in museums to interpret the subject to the public.

1. Text matters (labels)
2. Paintings and Photographs
3. Computer prepared vinyl charts
4. Semi dioramas (relief work)
5. Dioramas (explaining a subject with 3Dimensional background)

6. Animated exhibits (working models)

A good account about the extinct life forms which have dissapeared from Earth permanently can be explained to the public in an efficient way by utilizing these methods. In addition to the importance of life and its periodical elimination from Earth the following topics can also be conveyed to the public in an efficient way.

1. Our declining forest areas
2. Forest types
3. Reserved forests and Protected forests
4. Essentiality of Forest wealth
5. Our faunal collections
6. Wild life Act
7. Bio reserves
8. National parks and Sanctuaries
9. Environmental protection agencies

Permanent exhibits or galleries are back bone of a museum. In addition to the permanent exhibits the museums can conduct lot of other educational activities like

1. Conducting periodic lectures
2. Conducting special exhibitions
3. Conducting training courses
4. Conducting competitions for school and college students
5. Conducting seminars
6. Conducting nature walks or trekking programmes
7. Conducting outreach programmes
8. By its publications in the form of pamphlets and books
9. Screening film shows
10. By the distribution of loan kits
11. By providing mobile vans or buses to the rural areas

12. Celebrating special days like World Forest day, Earth day etc.,

13. By computer aided display

Future museums : Even today's science centers and science museums provide lot of specialized audio visual programmes for the popularization of science. Future museums will have specialized virtual galleries and virtual tours where learning is fun and the topic of biodiversity will be conveyed to the public and students in an efficient way.

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Couropita guianensis, (cannon ball tree) - The gorgeous view of the tree at Government Museum, Chennai